

**Aurizon Network 2014
DAU – response to
submissions on WACC**

**Queensland Competition
Authority**

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1. Executive Summary

1.1 Background and Brief

Aurizon Network's 2010 access undertaking is due to expire on 30 June 2015. On 30 April 2013, Aurizon Network submitted a voluntary draft access undertaking (the 2013 DAU) to the Queensland Competition Authority (QCA or 'the Authority') for approval. The Authority engaged Incenta Economic Consulting (Incenta) to provide reports on the benchmark cost of debt and equity beta appropriate to Aurizon Network's circumstances, and these reports were completed in November and December 2013. In April 2014, following receipt of submissions from stakeholders on the 2013 DAU, Incenta updated the two reports, and on 30 September 2014, the Authority released a draft decision on the proposed Maximum Allowable Revenue (MAR) for the 2014 DAU period. The draft decision proposed a WACC of 7.17 per cent, based on a debt risk premium of 2.72 per cent and an asset beta of 0.45, which implied an equity beta of 0.8.

On 22 December 2014, the Authority received 10 submissions from stakeholders on the MAR draft decision. Five submissions commented specifically on the QCA's proposed debt margin and/or asset/equity beta, and in March 2015, a further submission was received from the Queensland Resources Council (QRC).

The Authority re-engaged Incenta to respond to the components of these submissions that relate to the findings in its reports. We have divided stakeholder submissions into debt risk premium and beta estimate issues corresponding to our two reports, and have considered each in turn. In relation to each issue raised we first set out the position put in the stakeholder submission, and then provide our response.

1.2 Debt risk premium

1.2.1 Econometric estimate

Aurizon Network's submission

Aurizon Network has observed that Incenta's conclusion that the predicted debt risk premium from its "pooled" sample of bonds – which has an (equally weighted) average credit rating very close to BBB+ – is equivalent to a BBB+ premium and assumes that the difference in premium between a BBB+ and A- bond is the same as between a BBB and BBB+ bond. This condition is required for the average debt risk premium between an A- and BBB bond to be indicative of the premium for a BBB+ bond. Aurizon Network submits that this assumption is false – it argues that, while the debt risk premiums estimated for A- bonds are statistically significantly lower than BBB+ debt risk premiums, there is not a significant difference between BBB and BBB+ premiums. In Aurizon Network's opinion this has resulted in downward bias in Incenta's econometric estimate of the 10 year BBB+ credit rated debt risk premium. Therefore, Aurizon Network considers it is appropriate to lump BBB and BBB+ bonds together when estimating the BBB+ debt risk premium, or to otherwise exclude the influence of A- bonds. Using the same bond sample as Incenta, Aurizon Network finds that by applying dummy variables that distinguish the BBB and A- bonds in the sample, a 10 year BBB+ debt risk premium estimate of 3.00 per cent is obtained, and if A- bonds are excluded from the sample the estimate becomes 2.99 per cent, which is materially higher than the debt risk premium of 2.72 per cent recommended by Incenta.

QRC's submission

QRC has submitted that the advantages of the econometric method for estimating the debt risk premium do not outweigh the advantages of using a third party source, and hence there is ‘no compelling reason not to use Bloomberg data to estimate the debt margin’.¹ QRC considers that if the econometric approach is to be taken into account it should be averaged with the Bloomberg estimate.

Incenta's response to Aurizon Network

We have considered the arguments of Aurizon Network and do not consider that the matters raised warrant a revision to our estimate.

First, we cannot replicate the results of Aurizon Network and we find that if we apply Aurizon Network's method (either using dummy variables or pooling the BBB and BBB+ bonds and omitting the A- bonds) we get an estimate of the debt risk premium that is only marginally higher than the figure that we recommended in our earlier report. Despite a request to Aurizon Network for the data underpinning its results (which would have permitted us to reconcile our respective calculations), this data was not provided.

Secondly, we do not agree that it can be concluded that the debt risk premium on BBB and BBB+ bonds are the same. In our view, the statistical finding that the premium is the same between the different credit ratings reflects the fact that the sample of BBB+ bonds is small, and contains several bonds (which we identified as potentially aberrant bonds in our earlier report) whose debt risk premiums are unusually large. Once these bonds are removed from the sample of BBB+ bonds, a statistically significant difference between BBB and BBB+ bonds is found. We also observe that the suggestion that the BBB and BBB+ debt risk premiums are the same is not consistent with finance theory or practice.² While we have left these potentially aberrant bonds in our calculations, this has not had a substantial impact on our results because of the much larger sample size that we have applied by virtue of pooling the bonds.³

[Aurizon Network's estimates based on application of dummy variables cannot be replicated](#)

Aurizon Network's use of dummy variables effectively produces individual debt risk premium estimates for the individual BBB, BBB+ and A- credit rating band samples. However, we cannot replicate Aurizon Network's findings with the sample that we used in our original report to derive a

¹ QRC (December, 2014), *QRC submission to the QCA: Aurizon Network 2014 Draft Access Undertaking – Maximum Allowable Revenue*, p. 25.

² We note that if there were a general consensus that BBB and BBB+ are indistinguishable there would be no point to the separate credit rating bands existing, and Ausgrid would not have made an appeal to the Australian Competition Tribunal for the benchmark regulatory credit rating to be amended from BBB+ to BBB. (See Ausgrid (21 May, 2015), *Application for leave and application for review by the Australian Competition Tribunal*, para. 133).

³ A finding that may be drawn from this is that the four DBCT bonds behaved more like BBB bonds than BBB+ bonds. Under our method, this finding would have caused us to revise slightly how we interpreted the “pooled” sample debt risk premium estimate: rather than saying that it is very close to BBB+ but very slightly in the direction of A- (as the sample contained 32 BBB, 18 BBB+ and 34 A-), we would have concluded that it was still very close to BBB+ but now very slightly in the direction of BBB (as the effective composition would become 36 BBB, 14 BBB+ and 34 A-).

10 year BBB+ debt risk premium estimate of 2.72 per cent. More broadly, we do not agree with Aurizon Network’s dummy variable approach since it creates smaller bond samples that are subject to greater estimation error. This is particularly the case for the BBB+ credit rating band, which has only 18 sample members.

The reason that the PwC method applies bonds on either side of the BBB+ credit rating band to estimate the debt risk premium for BBB+ bonds is that this provides a much larger sample of bonds, which reduces the scope for estimation error. Typically only 15 to 20 BBB+ bonds satisfy the selection criteria, while there can be up to 80 or 90 bonds in the sample if BBB and A- bonds are included. There is a risk of some bias resulting from the inclusion of BBB and A- bonds, but the PwC method accepts this risk as long as the overall weighting (using the simple system) is relatively close to an average BBB+ (i.e. close to 2). On the other hand, we consider there is much greater potential for bias if BBB and BBB+ bonds are combined, or only a small sample of BBB+ bonds is relied upon. While the PwC weighting system is relatively simple, it is difficult to imagine what kind of weighting system could replace it, given that the specific risk characteristics determining the debt risk premiums of the sample bonds are unknown. The PwC system involves a trade-off, in that an imperfect weighting system is applied in order to obtain many more bond data points, which in our view increases the accuracy of the estimate of the 10 year BBB+ debt risk premium.

Table ES.1 shows Aurizon Network’s finding of an approximately 3.0 per cent debt risk premium estimate if dummy variables are used to identify BBB and A- bonds. However, when we apply the same method to the data that we used to estimate a 10 year BBB+ debt risk premium of 2.72 per cent, we obtain a different result, which is approximately 2.80 per cent (or 8 basis points more than our original estimate). That is, we cannot replicate Aurizon Network’s findings using the bond data that was used to obtain the debt risk premium estimate of 2.72 per cent. The 8 basis points difference from our estimated debt risk premium of 2.72 per cent is small, and moreover we are more confident about our estimate as it is based on the much larger sample of 84 bonds (compared with 50 BBB and BBB+ bonds or 18 BBB+ bonds).

Table ES.1: Regression results using dummy variables, debt risk premium – 20 days to 31 October, 2013

	Incenta			Aurizon Network		
	Coefficient	T-Stat	P value	Coefficient	T-Stat	P value
Intercept	1.641	11.189	4.89E-17	1.566	10.906	1.71E-17
Term	0.115	5.646	2.38E-07	0.143	7.147	3.71E-10
A- Dummy	-0.541	-4.462	2.63E-05	-0.526	-4.420	3.07E-05
BBB Dummy	0.005	0.042	0.966	0.012	0.103	0.91809
Est. 10 Yr BBB+	2.796			2.998		

Source: Bloomberg, UBS, Incenta analysis

The debt risk premium differential between BBB and BBB+ bonds is dependent on the inclusion of DBCT bonds

Aurizon Network’s finding of no statistically significant difference in the debt risk premiums of BBB and BBB+ credit rated bonds is dependent on whether four Dalrymple Bay Coal Terminal (DBCT)

bonds are included in the analysis. In our original report we showed a sensitivity that excluded the DBCT bonds because there has been some controversy about whether these bonds are representative of BBB+ bonds, given that they were originally ‘credit wrapped’ AAA-rated bonds that had been downgraded during the global financial crisis.⁴ Whilst the inclusion of these DBCT bonds did not have a large bearing on our results due to the relatively large sample of 84 bonds that we employed, interpretation of the BBB+ sample of bonds was very sensitive to whether these bonds were included.⁵

Table ES.2 below shows that when the DBCT bonds are included the average net vertical difference of each debt risk premium value from the BBB+ regression line is 22.7 basis points for BBB bonds, and 18.7 basis points for BBB+ bonds. The BBB and BBB+ differentials are found not to be statistically significant and the BBB+ bonds are on average above the regression line, as noted by Aurizon Network. On the other hand, the debt risk premiums of the A- group of bonds are found on average to be 30.8 basis points below the BBB+ regression line, which is statistically significant at well beyond the 1 per cent level for a one-tail T-test.⁶

Table ES.2: Relative mean differences from pooled regression line (basis points) for 20 days to 31 October, 2013

Credit rating	N	Including DBCT		N	Excluding DBCT	
BBB	32	22.7		32	22.7	
BBB+	18	18.7		14	0.8	
		Unequal Var.	Equal Var.		Unequal Var.	Equal Var.
T-statistic		-0.297	-0.316		-2.304	-2.037
Prob. - 1 tail		0.384	0.377		0.014	0.024
BBB+	18	18.7		14	0.8	
A-	34	-30.8		34	-30.8	
		Unequal Var.	Equal Var.		Unequal Var.	Equal Var.
T-statistic		3.832	4.219		3.100	2.820
Prob. - 1 tail		0.000	0.000		0.002	0.004

Source: Bloomberg, UBS, Incenta analysis

However, these results change materially when the DBCT results are excluded, as shown in the right hand column of Table ES.2. We find that the average difference between the debt risk premium for the sample of BBB+ bonds and the regression line is now only 0.8 of a basis point, and that the mean debt risk premium differential of the BBB+ group is now statistically significantly different from the

⁴ Incenta (November, 2013), p.28. It has been argued that these bonds may be ‘tainted’ by their downgrade experience and therefore attract a higher yield than the typical BBB+ bond of the same term to maturity.

⁵ If only the 18 BBB+ bonds (including the DBCT bonds) are employed in the regression, the estimated 10 year BBB+ debt risk premium is 274 basis points (i.e. only 2 basis points higher than if all 84 bonds are used); and if the 4 DBCT bonds are excluded from the regression using only BBB+ rated bonds (i.e. the sample is reduced to 14 BBB+ bonds), the estimated 10 year BBB+ debt risk premium falls to 237 basis points.

⁶ A one-tail T-test is appropriate because theory suggests that for a given term, BBB bonds should attract a higher debt risk premium than BBB+ bonds, and that BBB+ bonds should attract a higher debt risk premium than A- bonds.

BBB bonds. The fact that the debt risk premiums of the 14 non-DBCT bonds are so well described by the pooled regression line (derived using all 84 bonds in the sample) gives us confidence that this approach provides the most accurate estimate of the debt risk premium for an average BBB+ rated bond at a term of 10 years. The utilisation of a large sample in the PwC method has largely neutralised the impact of the DBCT bonds and any other idiosyncratic features.

Lastly, a further corollary of the table and discussion above is that, once the DBCT bonds are removed from the sample, the difference in the debt risk premium between a BBB and BBB+ credit rating is very close to the difference in premium between a BBB+ and A- credit rating. This means that the underlying assumption of the method we have applied that Aurizon Network challenged – namely, that the average of a BBB and A- debt risk premium is indicative of BBB+ – is shown to be supported by the evidence.⁷

Incenta's response to QRC

Our brief for our original report required us to provide estimates of the debt risk premium using PwC's econometric, and extrapolated Bloomberg 'paired bonds' methods. Whilst we agree with QRC that it would be ideal to rely on a third party provider of BBB+ fair value bond yields, at the time of Aurizon Network's averaging period (which ended with 31 October, 2013), only the Bloomberg fair value curve was available, and it provided yield estimates only to 7 years.⁸ Furthermore, there have been times when the Bloomberg fair value yield curve has not been reliable (for example during the global financial crisis, when it under-estimated bond yields). As discussed below, as at 31 October 2013 the RBA method estimated a 7 year BBB bond yield that was materially higher than the Bloomberg estimate, and the change in the debt risk premium between 7 to 10 years as estimated by the RBA method was extremely high

In addition, it is not clear to what extent the BBB bond yield estimated by the RBA or Bloomberg can be considered representative of a BBB+ bond yield. Past experience has shown that the Bloomberg BBB fair value curve has provided a reasonable estimate of the yield on BBB+ rated bonds at a term of 10 years, but there is no evidence relating to the RBA's BBB curve. Both theory and empirical evidence suggest that relative to BBB+ rated bonds, bonds with a BBB credit rating will need to offer an additional return in order for investors to take them up. In light of these issues with third party provider data, it is our view that the PwC econometric method provides a consistent and rigorous alternative that is specifically aimed at estimating the 10 year BBB+ debt risk premium, and can be adapted to estimate the 10 year BBB debt risk premium. The QCA has adopted this approach as its primary method for estimating the debt risk premium.

⁷ We have also confirmed that if the regression equation reported earlier with dummy variables included for the A- and BBB bonds is re-run with the DBCT bonds excluded then the absolute values of the coefficients on the dummy variables are very similar. This finding also supports our assumption that the average between an A- and BBB debt risk premium is indicative of a BBB+ premium.

⁸ The RBA commenced producing a fair value curve in December of 2013, although it provided backdated calculations to 2005 at that time.

1.2.2 Incenta’s Bloomberg debt risk premium estimate is an outlier

Aurizon Network’s submission

Aurizon Network has submitted that Incenta’s estimate of the debt risk premium that was obtained by the application of the Bloomberg 7 year BBB fair value curve and then extrapolated to 10 year by applying what is known as the “paired bonds” method (which resulted in a 10 year BBB+ debt risk premium of 2.51 per cent), is an outlier compared with alternative estimates. Aurizon Network submitted that this is materially lower than what would have been obtained using the Australian Energy Regulator’s (AER’s) current method, which would have resulted in an estimate of 3.60 per cent if it was applied at 31 October, 2013. Aurizon Network considers that the AER’s current method would:

- Assign 50 per cent weight to the debt risk premium obtained from the fair value curve that is produced by the Reserve Bank of Australia for the 10 year BBB credit rating band (3.91 per cent); and
- Assign 50 per cent weight to the 3.28 per cent debt risk premium that is obtained by commencing with the 7 year Bloomberg BBB debt risk premium and then extrapolating this to 10 years using the change in the RBA BBB yield curve estimate.

Note that in the AER’s current method, the RBA fair value curve enters the calculation twice – once as a direct estimate of the 10 year BBB premium, and a second time because the part of the RBA fair value curve between terms of 7 years and 10 years is used to extrapolate the Bloomberg debt risk premium to a term of 10 years.

Incenta’s response

We could not have applied the AER’s current debt risk premium estimation method in our original report because the AER only adopted its current method after that report had been completed and similarly the RBA had not commenced producing its fair value curve for corporate bonds. To be clear, if the AER had estimated the debt risk premium for the averaging period applicable to Aurizon Network, it would not (and indeed, could not) have applied its current method. Moreover, our brief from the QCA required us to provide estimates of the debt risk premium using PwC’s econometric, and Bloomberg extrapolation (‘paired bonds’) methods.

Moreover, we do not agree with Aurizon Network’s opinion that the estimated debt risk premium of 2.51 per cent based on PwC’s paired bonds method is an outlier compared to the methods that were available at the time, and furthermore consider that if the AER’s current method was to be applied to the averaging period then the outcome of that method would have been more correctly classified as unreliable and “an outlier”.

The Authority’s brief required us to apply the two debt risk premium estimation methods that were recommended by PwC (2013), and are referenced by the QCA. This issue relates to the second estimation method recommended by PwC, namely the use of the Bloomberg BBB fair value curve extrapolated from a 7 year term to a 10 year term using the “paired bonds” method, which it recommended be used as a cross-check against its primary method, the econometric estimation method.

Aurizon Network is not correct in proposing that the estimated debt risk premium of 2.51 per cent based on PwC's paired bonds method is an outlier. There are two differences between the method advocated by Aurizon Network and the method we applied, namely:

- Whether the debt risk premium for BBB+ rated debt at 7 years under the alternative method is appropriate (from the discussion above, Aurizon Network's method in effect commences with a 7 year debt risk premium that is the average of the premium provided by the RBA and Bloomberg fair value curves, whereas the method we applied commenced only with the Bloomberg value), and
- Whether the extrapolation that is applied to convert the 7 year debt risk premium into a 10 year debt risk premium is appropriate (from the discussion above, Aurizon Network's method is to use the change in the debt risk premium between 7 and 10 years provided by the RBA fair value curve to extrapolate the debt risk premium from 7 to 10 years, whereas we used the "paired bonds" method).

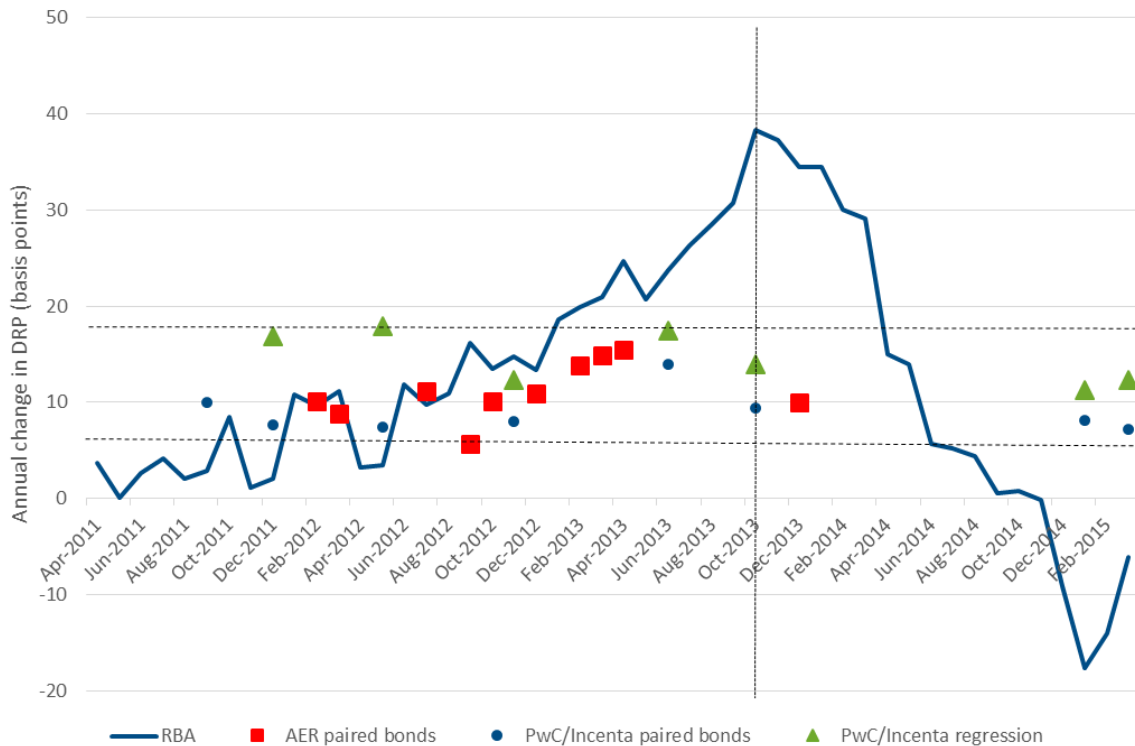
Of these two differences, it is the second difference (the choice of extrapolation method) that accounts for most of the gap between Aurizon Network and ourselves. Our view is that the extrapolation that was provided over this period by the RBA fair value curve was unreliable and should not be used.

Over the past two years the 7 to 10 year debt risk premium provided by the RBA fair value curve has displayed significant volatility. At the time of Aurizon Network's 31 October 2013 averaging period, the estimate of the change in the debt risk premium with term was at its maximum of 38 basis points per annum (bppa) between 7 and 10 years (i.e. a total extrapolation of 114 basis points from 7 to 10 years). More recently, the RBA's BBB debt risk premium estimate between 7 and 10 years has become negative, and we note that it has been negative for approximately 14 per cent of the time since 2005.⁹

The volatility of the RBA fair value curve's implied debt risk premium between 7 and 10 years is displayed in Figure ES.1 below. In this figure we have superimposed the annual changes in the debt risk premium between 7 and 10 years that were applied by the AER in its decisions and by PwC and Incenta in its previous reports, all of which over this period used the paired bonds method to extrapolate. We have also shown the annual change in the debt risk premium between 7 and 10 years that has been obtained by PwC and Incenta in previous reports using the econometric method.

⁹ The 7 to 10 year debt risk premium has been negative 14.2 per cent of the time from January 2005 to April, 2015, not counting 11 months in 2007-08 when the 7 year debt risk premium was not available.

Figure ES.1: Annual change in BBB debt risk premium (7 to 10 years) – RBA vs regression and paired bonds analysis (basis points per annum)



Source: RBA Table F.3, AER decisions, PwC and Incenta reports.

The relative stability of PwC’s Bloomberg extrapolation (“paired bonds”) and econometric methods is apparent, with the former method’s per annum change in the debt risk premium between 7 and 10 years ranging from 5.7 to 15.5, and the latter method’s rise ranging from 12.3 bps to 17.9 bps in the period between 2011 and 2015.

Turning to the first of the differences noted above, we note that as at 31 October, 2013 the 7 year debt risk premium estimated by each method were:

- Approximately 2.74 per cent using the RBA BBB fair value curve (this reflects the average yield reported for the September and October month ends – the RBA only reports month-end figures);¹⁰
- 2.37 per cent using Bloomberg (based on the BBB yield of 6.12 per cent for the 20 days to that date); and

¹⁰ This approximation is the debt risk premium based on the annualised estimated yield for the 6.94 year effective term of the RBA bonds for the September and October 2013 month ends, and the annualised CGS yield at a term of 7 years averaged over the 20 business day period from 2 October, 2013, to 29 October 2013.

- 2.31 per cent using the PwC econometric method (based on the BBB+ yield for the 20 days to that date).

Hence, in addition to an unusually high change in the debt risk premium between terms of 7 and 10 years at 31 October, 2013, the RBA method was estimating a 7 year BBB debt risk premium that was already approximately 37 basis points higher than the yield Bloomberg was estimating, and approximately 43 basis points higher than the 7 year BBB+ yield estimated using the PwC econometric approach. We take comfort from the fact that the Bloomberg and econometric approaches yielded very similar results, and in contrast consider the RBA value to be out of step.

Finally, we reiterate that as at October, 2013, the AER did not have a policy of applying the RBA's BBB yield data to estimate the cost of debt for a benchmark 10 year term BBB+ bond. The AER's policy of providing equal weighting to the RBA data and the extrapolated Bloomberg method using the RBA's BBB debt risk premium change between 7 and 10 years was only introduced in 2014. Rather, the method that we have applied as a cross-check of the econometric estimates – which was to commence with the Bloomberg 7 year BBB debt risk premium and extrapolate this to 10 years using the “paired bonds” method – is the method the AER applied at the time. As shown in Figure ES.1, the extrapolation that we estimated using the paired bonds method is very close to what the AER applied in its decision that was closest in time. Moreover, in view of the erratic nature of the RBA “fair value curve” between 7 and 10 year terms around the time of the Aurizon Network averaging period, we do not think the AER's new method could be expected to provide a more accurate estimate of the debt risk premium during this averaging period.

1.2.3 There are discrepancies in Incenta's paired bonds analysis

Aurizon Network's submission

Aurizon Network's submission notes that for two of the four pairs of bonds used by Incenta in its paired bonds analysis the longer term bond was not included in the sample of bonds used in the econometric analysis, and on a strict application of the PwC paired bonds method should not have been included.¹¹ Aurizon Network submits that by excluding these two pairs the paired bonds estimate of the debt risk premium would increase from 2.51 per cent to 2.64 per cent.

Incenta's response

We acknowledge that Aurizon Network is correct in its observation that the two longer term bonds (both with A- credit ratings) should not have been included in the bond sample on a strict application of PwC's paired bonds method. This was because these two bonds did not have BGNs ('Bloomberg Generic Price'), which is Bloomberg's 'market consensus view' of the yields that are supplied to it on a daily basis by financial institutions. This number is subject to Bloomberg analyst judgement (i.e. it is not a mechanical formula). However, Bloomberg also supplies yield estimates for bonds based on its Bloomberg Valuation Service (BVAL), and in the period since the PwC (June, 2013) report was completed, Bloomberg's emphasis shifted (in April, 2014) over to BVAL. We agree that if only the BBB+ bond pair (SP AusNet) was used for guidance, an estimate of 2.61 per cent would have been obtained using this method. However, if only the BBB bond pair and BBB+ pair were used the

¹¹ These two bonds were issued by Commonwealth Property Fund and General Property Trust.

estimate would be 2.63 per cent. Accordingly, we have raised our estimate of the debt risk premium that is obtained by the second method from 2.51 per cent to 2.63 per cent.¹² We note, however, that this premium remains lower than the econometric estimate (2.72 per cent) that the QCA has used as its primary indicator.

We also note that since the PwC report was completed (June, 2013), Bloomberg’s emphasis has shifted from BGNs to BVAL yields, and significantly more bonds are now available using the latter yields. Given these changes, we consider that BVAL yields should in future be applied in both the econometric and paired bond analyses.

1.2.4 Conclusion on the debt risk premium

Having reviewed Aurizon Network’s submission on the debt risk premium, we remain of the view that our original econometric estimate of 2.72 per cent is the appropriate econometric estimate of a 10 year BBB+ debt risk premium for the 20 business days to 31 October, 2013. As discussed above, there were relatively few BBB+ credit rated bonds available (18), of which we have expressed concerns about 4. In those circumstances, we think that a more reliable estimate of the yield for a BBB+ bond is obtained by pooling the 84 BBB, BBB+ and A- credit rated bonds – noting that the numbers of BBB and A- bonds are approximately equal – which resulted in an estimate of the debt risk premium for a 10 year BBB+ bond of 2.72 per cent. We think it is reasonable to have more confidence in this estimate than in the estimates implied by the alternative econometric methods proposed by Aurizon Network

In relation to the method we applied as a cross check – which used as a base a publicly available fair value curve – we do not accept that the method we applied is an outlier or inappropriate. Rather, we think the alternative method that Aurizon Network advocated – which was to back-date the AER’s current method to a historical period – would have resulted in an estimate that is unreliable. However, we accept Aurizon Network’s comment that we made an error in applying our stated method, and remedying this error increases the alternative estimate of the debt risk premium from 2.51 per cent to 2.63 per cent. However, as this remains below the value applied by the econometric method, we continue to recommend applying a value of 2.72 per cent.

1.3 Beta estimate

1.3.1 Incenta included Grant Samuel’s beta estimate for DBCT but ignored its estimate for WestNet Rail (now Brookfield Rail)

Submission by SFG

SFG Consulting (SFG) has submitted that whilst Incenta applied a ‘lower bound’ beta estimate of 0.35 (based on the Dalrymple Bay Coal Terminal (DBCT)) for Aurizon Network drawn from a Grant Samuel independent expert report, it ignored the much higher estimated equity beta of 1.0 to 1.1 that Grant Samuel applied to WestNet Rail (now Brookfield Rail) for a gearing of only 20 per cent to 25 per cent, which was ‘*by the same expert, in the same report*’ (emphasis in original). In SFG’s opinion,

¹² While Aurizon Network obtained an estimate of 2.64 per cent using both the BBB and BBB+ bond pairs, the estimate we obtained was 2.63 per cent.

since WestNet Rail is a railroad business it is a natural comparator for Aurizon Network, but Incenta has instead chosen toll-roads to define its upper bound estimate.

Incenta's response

We do not agree with SFG's opinion that WestNet Rail (Brookfield Rail) is an appropriate comparator for Aurizon Network's operations, because our extensive first principles analysis contained in our original report demonstrated that they were not comparators. The fact that they are both below rail firms is not a reason to rely on WestNet Rail, just as Grant Samuel did not rely on container port comparators to estimate the beta for DBCT, which is a coal port subject to explicit cost-based regulation.

The emphasis that SFG places on the identification of our 'lower bound' and 'upper bound' asset betas suggests it believes that these 'bounds' played a dominating role in our analysis. However, this is not the case. Based on an extensive first principles analysis that reviewed the systematic risk characteristics of a number of candidate industries, we determined that the regulated energy and regulated water sector firms in our sample were the best comparator groups for Aurizon Network. Our estimated asset beta of 0.42 (which has now been revised to 0.41) was largely based on the asset beta evidence for those two industries, with the estimates for DBCT and toll-roads acting as frames of reference. That is, based on first principles analysis we considered the systematic risk characteristics of regulated energy and water businesses to lie between the 'lower bound' estimate (an opinion of an independent expert on the asset beta of DBCT), and the 'upper bound' estimate (evidence on the asset beta of toll-roads). Our view was that it is relatively unlikely that the asset beta of Aurizon Network would lie below that of Grant Samuel's opinion on DBCT, and it is also unlikely to lie above the evidence for toll-roads, even though individual estimated asset betas for some regulated energy and water businesses in our comparator samples lie below and above these two 'bounds'.

1.3.2 Canadian railroads should be used as comparators for Aurizon Network

Submission by The Brattle Group

The Brattle Group submits that some weight should be placed on Canadian railroads as comparators for Aurizon Network owing to the practice of the Canadian Transportation Agency (CTA).¹³

... their regulated services consist of western grain and interswitching with the regulated cost of capital being determined for western grain. Thus the regulatory regime is similar in that the CTA sets the allowed return on equity for a single raw material... We noted that the Canadian Transportation Agency uses the beta estimate for the Canadian railroads to determine the cost of capital for Western grain and interswitching (and a few other purposes).

Incenta's response

In our view it is inappropriate to apply the beta of Canadian railroads to estimate the beta of regulated grain traffic, nor is it appropriate to apply the beta of Canadian railroads as a comparator for Aurizon Network, which is subject to cost-based regulation. We are aware that the CTA has applied a beta

¹³ The Brattle Group (17 December, 2014), p.9.

estimated from the Canadian railroads to regulated wheat traffic, but we disagree with this approach because (i) wheat traffic is a relatively minor component of total Canadian railroads traffic, and (ii) we think that first principles analysis suggests that the systematic risk of the wheat trade is materially different from that of its unregulated traffic. Consistent with this, the CTA's method has also been criticised by the State of Manitoba, which has pointed out that in 2009 only 6.3 per cent and 10.8 per cent respectively of Canadian National's and Canadian Pacific's overall revenue was from grain traffic, and furthermore:¹⁴

The carriage of grain is a risk-reducing factor for the railways for two reasons. First, the railways have a virtual monopoly over the long-distance carriage of Canadian grain, which reduces the risk of transporting this commodity relative to most of the rest of the railways' traffic... The second reason that grain transportation is less risky is that the volume of grain is not tied to the general economy, as with other commodities and merchandise that are transported by rail.

Manitoba noted that during the global financial crisis the carriage of grain actually increased when other traffic reduced markedly. This supports the findings in our original report, which showed that Canadian rail movements in agriculture declined only 1.6 per cent between 2008 and 2009 (the global financial crisis), while coal declined 21.9 per cent, automotive traffic declined 31.2 per cent and intermodal declined 20.6 per cent.¹⁵ The Brattle Group did not comment on these relativities, or the fact that these traffic components that are relatively sensitive to economic conditions constitute close to 90 per cent of the total traffic of the Canadian railroads.

1.3.3 Tollroads, WestNet Rail, and energy businesses as comparators

Submissions by Aurizon Network SFG and QRC

SFG submits that Standard & Poor's considers WestNet Rail (Brookfield Rail) to be a comparator for Aurizon Network's risk exposure, but not regulated energy firms. Aurizon Network also submits that the Economic Regulation Authority of Western Australia (ERAWA) provided a 'more balanced' assessment of the asset beta of WestNet Rail (Brookfield Rail) because it had taken account of US Class 1 railroads and Australian and New Zealand transport companies even though 80 per cent of its traffic was bulk resource and agricultural commodities. Furthermore, the ERAWA's adviser considered toll-roads to be appropriate comparators for the Western Australian Public Transport Authority (PTA), which in Aurizon Network's view must have less systematic risk than Aurizon Network's operations because it encompasses passenger rail transport.

On the other hand, QRC submits that 'due to their much higher risk exposure ... toll roads are not an appropriate comparator for Aurizon Network', and 'Their inclusion in Incenta's comparator set has the effect of artificially widening the range of estimates for Aurizon Network's beta, and biasing upwards the point estimate.'¹⁶

¹⁴ Manitoba (20[10]), *Comments on the Cost of Capital Methodology Used by the Canadian Transportation Agency*, pp.2-3, and pp.12-13.

¹⁵ Incenta (9 December, 2013), Table 3.3, p.35.

¹⁶ QRC (December, 2014), p.23

Incenta's response

With respect to SFG's observation that Standard & Poor's uses WestNet Rail (Brookfield Rail) as a comparator for Aurizon Network, we note that Standard & Poor's is concerned with credit risk rather than systematic risk, and therefore this observation is not relevant to Aurizon Network's systematic risk.

ERAWA's adviser did consider 'mature toll-road companies' to be a comparator for Perth's PTA, and we also agree with Aurizon Network that the PTA should have less systematic risk than Aurizon Network. However, we disagree with the view that mature toll-road companies are appropriate comparators for Perth's PTA, since no detailed first principles analysis of the relative systematic risk characteristics of Perth's PTA and mature toll-roads was undertaken to establish that this was the case. Based on our own first principles analysis of toll-roads, we consider that if such an analysis had been undertaken, it would have concluded that since toll-roads are not regulated on a cost-of-service basis and are more vulnerable to economic cycles than is the PTA, they are not an appropriate comparator for the PTA. In any event, we note that the asset beta of toll-road companies estimated in 2007 was very low, as it caused the ERAWA to adopt an asset beta of 0.30 (Harris and Pringle, with a zero debt beta) for PTA. At the time this was below the asset beta range that regulators were applying to energy networks (which was 0.40 using the same delivering method).

In our view WestNet Rail is quite different to Aurizon Network, and hence the fact that the ERAWA used Class 1 railroads and other transport companies as comparators for it is not relevant to Aurizon Network. In the circumstances of WestNet Rail there may well have been justification to place some reliance on Class 1 railroads and other transport companies, and we note that the asset beta adopted by the ERAWA for WestNet Rail was lower than the asset beta of Class 1 railroads.

We agree with QRC that toll-roads are likely to have higher systematic risk exposure than Aurizon Network, which is why we considered the estimated asset beta of toll-roads to be an 'upper bound'. We did not give specific weight to toll-roads when estimating the asset beta of Aurizon Network, but expected Aurizon Network's asset beta to lie below the asset beta of toll-roads.

1.3.4 Impact of regulation

Submissions by Aurizon Network, SFG, The Brattle Group and Anglo American

SFG's submission considers that while Incenta has claimed that the regulation of Class 1 railroads is not comparable with that applying to Aurizon Network, Incenta was able to provide no evidence that regulation influences beta. Aurizon Network quotes a number of academic studies that it submits provide a range of outcomes about the impact of regulation on beta: 9 show a decrease in beta, 8 show an indeterminate effect and 3 show an increase in beta.

Both Aurizon Network and The Brattle Group submit that Aurizon Network's revenue regulation does not guarantee that it has stable cash flows. The latter provides evidence that the standard deviation of revenue for Aurizon Network is higher than for Class 1 railroads.

Anglo American’s submission on the other hand, ‘reiterates its concerns that Incenta’s approach incorrectly simplified the categorisation of benchmarks and, therefore, that the QCA’s question in relation to risk reduction mechanisms was not appropriately answered.’¹⁷

Incenta’s response

Response to SFG

There is no inconsistency in our approach on regulation, since the evidence we reviewed in our original report considered whether different forms of cost-based regulation (e.g. revenue vs price regulation) have different levels of systematic risk. The key difference between Aurizon Network and Class 1 railroads is that Aurizon Network is subject to cost-based regulation that constrains earnings and provides services that have a substantial value to its customers (which provides revenue protection), whereas the regulatory framework applying to Class 1 railroads does not constrain their earnings, and nor do they have sufficient market power to be protected from market forces. Hence, this is not a question of form of cost-based regulation, but rather the presence of cost-based regulation (Aurizon Network and regulated energy and water businesses) compared with firms that are practically unconstrained (nor protected) by cost-based regulation (Class 1 railroads).

The studies referred to in the table presented by Aurizon Network are all from a 1999 academic study by Binder and Norton, and do not include the results of the Binder and Norton study itself, which supported the Peltzman ‘buffering hypothesis’.¹⁸ More fundamentally, almost all of the cited studies did not compare a situation with no cost-based regulation to one in which cost-based regulation is imposed. Hence, the vast majority of studies in the table did not comment on the effect of cost-based regulation *per se*.

Our original report did not claim that cost-based revenue regulation eliminates variability in Aurizon Network’s revenue, but rather that it results in a relatively lower systematic risk. The evidence of revenue instability provided by The Brattle Group does not relate those movements to the wider market. For systematic risk to be high, the revenue movements would need to co-vary with the market. Accordingly, the indicator that The Brattle Group focussed upon in this regard is irrelevant to the question of beta risk.

To this end, we note that in the case of Class 1 railroads revenue fell with the market in the global financial crisis, while Aurizon Network’s revenue rose. The revenue ‘instability’ that The Brattle Group estimates for Aurizon Network is actually just the effect of the changes to Aurizon Network’s revenue flowing from new capital expansions and the earning of regulated returns on that new capital. Thus, the hikes in revenue observed for Aurizon Network were the expected consequences of capital investment, not indicators of uncertainty or risk (whether systematic or non-systematic).

¹⁷ Anglo-American (December, 2014), *Submission to the Queensland Competition Authority – Response to the QCA Draft Decision on Aurizon Network’s maximum Allowable Revenue*, p. 12.

¹⁸ Binder, J.J. and S.W. Norton (1999), ‘Regulation, Profit Variability and Beta,’ *Journal of Regulatory Economics*, Vol. 15, pp. 249-265.

Response to Anglo American

In relation to Anglo American's submission, the regulatory approaches that we categorised were designed to test whether the asset betas of alternative forms of cost-based regulation could be distinguished. The extent of categorisation we applied already resulted in groupings that were relatively small, making it difficult to discern material differences in asset beta. Any finer categorisation would have meant smaller groupings still, and even less chance of finding such differences.

1.3.5 Transurban as an outlier in the toll-roads sample

The Brattle Group submission

The Brattle Group has submitted that the cash flow to capital expenditure ratio (CF/capex) of Transurban identifies it as an outlier relative to other toll-roads, and since Transurban's asset beta estimate is relatively low, its exclusion from this industry sample would markedly increase the beta estimate for toll-roads.

Incenta's response

We disagree with the Brattle Group's analysis of toll-roads, as it is incomplete or inconsistent in several dimensions:

- The Brattle Group's analysis is for the year 2014 only, whereas our asset beta estimates rely on data for the period 2003 to 2013;
- The Brattle Group relies on Bloomberg estimates of equity beta rather than asset beta;
- Of the 7 firms in our toll-roads sample, The Brattle Group includes only four firms in its analysis; and
- For one of the four toll-roads it examines (Gruppe Eurotunnel SA, or 'Gruppe') the Brattle Group omits data for the critical CF/capex ratio.

While The Brattle Group states that data for the CF/capex ratio was not available for Gruppe, we found that it is available in Bloomberg, and that for the period 2003 to 2013 this ratio was quite similar to Transurban (i.e. both were much higher than for the remaining 5 firms). If on these grounds both Transurban and Gruppe were to be excluded as outliers, the average (median) asset beta for the remaining toll-roads would be 0.51 (0.49), which is similar to the full toll-roads sample (0.49 and (0.49) respectively as shown below).

A broader view of investing activity is obtained by taking the ratio the operating cash flow to cash flow from investing (CF/CF from investing, where 'investing' includes capex). On this metric we find that Transurban is positioned in the middle of the toll-road industry group, while Gruppe is still

significantly higher than all other firms in the group.¹⁹ If Gruppe alone were to be excluded from the toll-road group the average (median) asset beta would remain at 0.49 (0.49). If Transurban alone were to be excluded from the toll-road group the mean asset beta would rise marginally from 0.49 to 0.50 (and the mean would rise from 0.49 to 0.51). Finally, we note that it is our view that toll-roads are likely to be exposed to greater systematic risk than Aurizon Network, and for this reason we have not included them as an appropriate comparator for Aurizon Network. Instead, we identified toll-roads as providing a likely upper bound to the range of asset betas for Aurizon Network. That is, we would expect the asset beta of Aurizon Network to be less than 0.49.

1.3.6 Aurizon Network and Class 1 railroads have similar market power

Aurizon Network's submission

Aurizon Network considers that Class 1 railroads have a similar level of market power to Aurizon Network.

Incenta's response

Aurizon Network has provided no convincing evidence that Class 1 railroads and Aurizon Network have similar levels of market power. Class 1 railroads are subject to competition between themselves and with other transport modes, while Aurizon Network is the only option for coal mines to transport their coal to the ports.

1.3.7 Operating leverage and growth option risk

Aurizon Network's submission

Aurizon Network has submitted that it has higher growth option risk than Class 1 railroads because approximately half of future investment in US rail infrastructure will be underwritten by the US Government. It has submitted that the measure of 'derived operating leverage' (DOL) used by Incenta was incorrect and must have been based on 'regulatory cash flows and not real cash flows'.

Aurizon Network submitted that two of Incenta's DOL proxy estimates for US Class 1 railroads will be substantially overstated 'as they do not take into account the large proportion of variable costs (i.e. fuel for train operations)'. Aurizon Network also submitted that while Incenta had calculated an opex/assets ratio of 8.4 per cent for it, the same ratio for Australian electricity transmission businesses was only 3.1 per cent, which implies that the operating leverage of Aurizon Network is actually much higher than for regulated energy businesses.

Incenta's response

As noted in our previous report, we do not consider that operating leverage or growth options will have a significant effect on the asset beta of firms subject to cost-based regulation, since the future returns will be regulated. In any case, there is no evidence to indicate that Aurizon Network has a similarly high degree of operating leverage as Class 1 railroads. In the main body of this report we

¹⁹ This implies that while Transurban's investment activity is not classified as 'capex' it still undertakes a significant amount of investment relative to cash flow, while Gruppe undertakes very little investment relative to cash flow.

have shown that the EBIT numbers that we relied upon were exactly the same as those used by Aurizon Network. As shown in Appendix D of our previous report, we calculated the ‘degree of operating leverage’ (DOL) using a regression approach that has not been used by Aurizon Network. Hence, Aurizon Network’s comparison with our findings is not correct.

The opex/assets ratio comparison made by Aurizon Network is not the relevant one. The more relevant comparison is with the average opex/assets ratio for the 70 businesses in our sample of international regulated energy businesses, since we have largely relied upon the estimated asset beta of this group. We find that the opex/assets ratio of Aurizon Network is in fact lower than for the regulated energy group sample, and that both are significantly lower than the US Class 1 railroads. We agree with Aurizon Network that the opex/assets measure is likely to overstate the relative operating leverage of US Class 1 railroads owing to their larger proportion of variable costs, however the opex/assets measure is used in academic papers as a proxy for degree of operating leverage, and we have also relied on the responsiveness of EBIT to sales. All three of our measures of operating leverage (including the inverse of the EBIT margin) indicate that Aurizon Network is more similar to regulated energy businesses than to US Class 1 railroads. Finally, we reiterate our view that operating leverage is unlikely to be important for determining the systematic risk of a regulated business like Aurizon Network, because regulation dampens earnings fluctuations and unhinges the remaining earnings volatility from systematic risk factors.

1.3.8 Application of the simulated month beta method

Aurizon Network’s and SFG’s submission

Aurizon Network submitted that Incenta incorrectly applied its own simulated month method in estimating asset betas for its samples of comparators with the result that in approximately half of the sample the distributions of simulated month betas were bimodal, and that this resulted in an underestimate of the correct asset beta estimate using that method.

QRC’s submission

QRC’s submission takes the view that the simulated month method is a departure from the conventional beta estimation method, and ‘results in a very significant increase in Incenta’s beta estimates for energy and water businesses.’

Incenta’s response to Aurizon Network and SFG

We acknowledge that our original data contained a bimodality in the distributions of the simulated beta results, which was an error that was caused by the inclusion of some aberrant data. The bimodality in our original data set was caused by the accidental inclusion of a set of earlier simulation results with the correct ones. However we have re-estimated the SIM-asset betas excluding the aberrant data and found very similar results in most cases. Using the clean data our SIM-asset beta estimate for the regulated energy sector has reduced from 0.42 to 0.41.

We individually examined all of the new distributions for each of the sample firms, and found that while only a small number are technically normally distributed (7 out of 107), almost all follow a unimodal pattern. In aggregate, the new beta estimates are close to those provided in our original

report.²⁰ As shown in Table ES.2 below, the coal and airport industry SIM asset betas increased marginally, while the toll-road industry SIM asset betas stayed approximately the same. For rail businesses the average SIM asset beta decreased slightly while the median increased slightly.

Importantly, the median SIM asset beta estimate for energy reduced only marginally from 0.42 to 0.41, while the average SIM asset beta stayed approximately the same at 0.41. The water average SIM asset beta reduced from 0.41 to 0.40, and the median value fell marginally from 0.40 to 0.38. Based on these marginal changes we revise our original recommendation of a 0.42 asset beta estimate for Aurizon Network to a recommended asset beta of 0.41.²¹

Table ES.2: New SIM asset beta estimates compared with previous SIM asset beta estimates

Industry	Number of firms	SIM asset beta - previous		SIM asset beta - revised	
		Mean	Median	Mean	Median
Coal	10	1.26	1.35	1.23	1.32
Rail	7	0.93	0.89	0.91	0.91
Airport	6	0.65	0.63	0.66	0.65
Tollroad	7	0.49	0.49	0.49	0.49
Energy	70	0.41	0.42	0.41	0.41
Water	7	0.41	0.40	0.40	0.38

Source: Bloomberg and Incenta analysis

We note that our revised SIM asset beta estimates are lower than the range of 0.51 (median) to 0.55 (average) reported by Aurizon Network.²² We cannot explain this differential, but in the next section below we show that this cannot be due to differing tax rate assumptions, or de-levering approaches. We also show that by using standard Bloomberg raw betas, rather than those that Incenta has itself estimated, an asset beta slightly lower than 0.41 is indicated based on the evidence for regulated energy and water businesses.

In addition, we note that a few months prior to the publication of our original report, Aurizon Network’s adviser, SFG, published a report that estimated the equity beta of 56 regulated international (i.e. US) and 9 regulated Australian energy businesses. SFG concluded that the average 60 per cent geared equity beta for these international regulated energy businesses was 0.82 (i.e. 0.89 and 0.58 for the respective groups of firms).²³ Applying the Conine formula, 55 per cent gearing, a corporate tax rate of 30 per cent, a gamma of 0.47, and a debt beta assumption of 0.12 results in an implied asset beta of 0.43. Hence, SFG’s estimate of the asset beta for Australian and US regulated energy businesses is only 0.02 higher than our estimate of 0.41, and is 0.02 lower than the 0.45 asset beta that has been applied to Aurizon Network in the QCA’s draft report.

²⁰ See Appendix A for further detailed comments on the econometric aspects of the simulation analysis, including a selection of the distributions matching the ones highlighted by Aurizon Network.

²¹ We note that the average and median estimates of the SIM asset beta remain at 0.41 if our international regulated energy and water business samples are combined.

²² Aurizon Network (19 December, 2014), p. 199.

²³ SFG, (24 June, 2013), *Regression-based estimates of risk parameters for the benchmark firm*, p.16. SFG gave double weighing to the 9 Australian firms in its sample.

Response to QRC

With respect to QRC's submission that the simulated months method results in a significant increase in Incenta's beta estimate for energy and water businesses, we note that our revised estimates of SIM asset betas for regulated energy range from 0.38 to 0.41 (see above), while the corresponding range using the conventional method is 0.35 to 0.38 (see below). That is, the difference in asset beta estimates is only 0.03.

1.3.9 Incenta has erred in de-levering the equity beta

Aurizon Network's submission

Aurizon Network submits that it cannot replicate the de-leveraging process used by Incenta, and that the discrepancies that arise between its estimates and those reported by Incenta cannot be explained by tax rates alone. Aurizon Network's submission provides a table of the statutory tax rates that it used for each country.

Incenta's response

We reviewed the de-leveraging approach that we used in our original report and confirmed that it contained no errors. To demonstrate the de-levering approach we used, in the main body of this report we have applied the deleveraging formula to American Economic Power (AEP), which is one of the 70 regulated energy firms in our sample. For the beta estimation period of 2003 to 2013, the annual average values for net debt, market capitalisation and effective tax rate of AEP (all readily verifiable from Bloomberg) are shown in Appendix A1.1 below.

With respect to the tax rate, our original report noted that we used effective tax rates on a firm by firm basis to de-lever the equity betas of sample firms, and applied them to the Conine formula assuming a debt beta of 0.12. It is appropriate to use the long term marginal effective tax rate that will be incurred by each business because the objective of de-levering is to strip out all effects except for the underlying systematic component. Often the statutory tax rate is applied as an estimate of the long term marginal effective tax rate, even if the current effective tax rate is lower than the current statutory rate. However, we have estimated long term effective tax rates for each firm (based on 10 years of data). We agree with Aurizon Network that it is unlikely that the differences between its estimates and our estimates of asset beta are due to the application of different tax rates in the de-levering process.

To illustrate sensitivity to alternative tax rates, and different beta estimation approaches, Table ES.3 below shows Incenta's revised OLS asset beta estimates for the toll-road and energy industries. We have revised our OLS estimates because the original report used the first day of each month to estimate the change in share price, while it is standard to use the last day of the month. Using effective tax rates the revised Incenta OLS mean and median asset beta estimates for the energy industry are both 0.39 and 0.38, which are 2 to 3 points below the revised (median) estimated SIM asset beta of 0.41. If statutory tax rates are used the mean and median asset betas using Incenta's OLS estimates are 0.40, which is still marginally below the 0.41 SIM asset beta that Incenta estimated.

Table ES.3: Asset betas - Effect of different tax rates and Bloomberg beta estimates

Tax rates	Revised Incenta OLS (effective tax rates)		Revised Incenta OLS (statutory tax rates)	
	Mean	Median	Mean	Median
Industry				
Toll-road	0.50	0.47	0.47	0.48
Energy	0.39	0.38	0.40	0.40

Tax rates	Revised Bloomberg OLS (effective tax rates)		Revised Bloomberg OLS (statutory tax rates)	
	Mean	Median	Mean	Median
Industry				
Toll-road	0.50	0.51	0.51	0.52
Energy	0.38	0.35	0.39	0.36

Source: Bloomberg, Incenta analysis

In the second panel of Table ES.3 we show the results using Bloomberg’s standard (raw) OLS beta estimates, which do not include dividend payments as part of the total monthly return on share ownership. For toll-roads the Bloomberg OLS asset beta estimates are slightly higher than Incenta’s OLS asset beta estimates (average (median) of 0.50 to 0.51 (0.51 to 0.52) compared with 0.47 to 0.50 (0.47 to 0.48)), and slightly lower for regulated energy businesses (average (median) of 0.3 to 0.39 (0.51 to 0.52) compared with 0.38 to 0.39 (0.35 to 0.36)). We find that the impact of statutory tax rates (relative to effective tax rates) is to add approximately one to two points to the beta estimate. Overall, the asset betas for the regulated energy industry based on Incenta’s OLS estimates and Bloomberg raw equity betas are slightly lower than the 0.41 estimated using the SIM beta estimation approach.

In addition, we reviewed whether our asset beta estimates for regulated energy firms and toll-roads were sensitive to our gearing estimates. In our original report (and in this report) gearing was estimated as the average of the Bloomberg daily market capitalisation (equity value) and quarterly or annual (depending on availability) net book debt values for the 10 year period ending June 2013 (or as many years as available). We checked our gearing estimates by defining net book debt as before (i.e. quarterly or annually), and market capitalisation on a matching quarterly or annual basis (depending on availability). We found almost precisely the same gearing and asset beta estimates for every firm in the sample and in aggregate.

1.3.10 Incenta has misclassified two firms into the wrong industries

Aurizon Network’s submission

Aurizon Network submits that in the data base supplied to it by Incenta, it identified that Incenta has misclassified:

- Societa Iniziative Autostradali e Servizi SpA, an Italian toll-road company, as a business in the airport industry; and
- CONSOL Energy, a US coal mining business, as a business in the energy sector.

Incenta's response

It is true that in the data file provided to Aurizon Network the two firms were misclassified, however this was transparently noted in Appendix D of our original report. Since the original misclassifications were found by us and corrected, they did not affect our results.

1.3.11 Conclusion on asset and equity beta

We have reviewed and responded to the concerns raised by stakeholders in relation to our original report. We consider that no issue raised by submissions causes us to revise our approach to estimating Aurizon Network's asset beta, and that Aurizon Network, SFG and The Brattle Group have not provided new evidence demonstrating that our first principles assessment of Aurizon Network's systematic risk was incorrect in concluding that its closest comparators are regulated energy and water businesses and in not placing any weight to rail and other transport firms. We continue to consider that placing weight on the asset beta estimates for this latter group of firms (as advocated by Aurizon Network and its advisers) will result in the estimated asset beta overstating the asset beta of Aurizon Network because it will be including evidence from firms that, from our analysis of fundamentals, are likely to be exposed to materially greater systematic risk than Aurizon Network. Again we note that independent experts Grant Samuel similarly did not attach weight to the betas of UK container ports when assessing the beta of DBCT, a regulated coal port.

In summary, we have observed a:²⁴

- 0.39/0.40 (average) to 0.38/0.40 (median) asset beta obtained from Incenta's own estimates of asset betas using our preferred method for the sample of 70 international regulated energy businesses (using effective/statutory tax rates);
- 0.38/0.39 (average) to 0.35/0.36 (median) asset beta if the asset betas produced by Bloomberg are applied for the sample of 70 international regulated energy businesses (using effective/statutory tax rates);
- 0.41 (average) and 0.41 (median) asset beta based on applying Incenta's (revised) SIM-beta method to the sample of 70 international regulated energy businesses (using effective tax rates);
- 0.43 asset beta estimate obtained by Aurizon Network's adviser (SFG) applying an OLS method to 56 US and 9 Australian regulated energy businesses; and
- 0.41 (average) and 0.41 (median) asset beta based on applying Incenta's (revised) SIM-beta method to the combined sample of 70 international regulated energy businesses and 7 international regulated water businesses (using effective tax rates).

²⁴ We have not placed weight on Aurizon Network's SIM-asset beta estimates for our 70 firm international regulated energy businesses sample (0.55 (average) and 0.51 (median)) because we cannot reconcile these figures with our estimates and with the unadjusted beta estimates (including just those obtained from Bloomberg) and so we believe that the figures are the product of an error or undisclosed methodological choice that we have not been able to review.

As in our original report, we continue to believe that greatest weight should be placed upon the SIM-beta figures for the energy and water businesses, which implies a point estimate for the asset beta of 0.41. We observe that the estimates reported above for these sectors fall within a fairly tight range of 0.35 to 0.43.

2. Background, Terms of Reference and outline of report

2.1 Background

On 30 April 2013, Aurizon Network submitted a voluntary draft access undertaking (the 2013 DAU) to the QCA for approval. It proposed an indicative post-tax, nominal vanilla WACC range of 7.27 per cent to 8.18 per cent, which was based on individual parameter ranges, including a debt margin of 2.94 per cent to 3.28 per cent and an asset beta of 0.5 to 0.6 (which corresponds to a (rounded) equity beta range of 0.9 to 1.0 at 55 per cent gearing and 0.12 debt beta using the Conine formula).

On 11 August 2014, Aurizon Network withdrew the 2013 DAU and submitted a further draft access undertaking (the 2014 DAU) to the Authority, which maintained the WACC proposals contained in the 2013 DAU. The QCA engaged Incenta to assist it in matters related to determining estimates of the regulatory cost of debt, asset/equity beta, capital structure, and benchmark credit rating for the regulatory WACC for Aurizon Network. Incenta subsequently produced the following reports:

- *Aurizon Network: Review of Benchmark Credit Rating and Cost of Debt (November, 2013)*
- *Review of Regulatory Capital Structure and Asset/Equity Beta for Aurizon Network (9 December 2013).*

In April 2014, following receipt of submissions from stakeholders on the 2013 DAU, Incenta updated these two reports for the Authority, and on 30 September 2014, the Authority released a draft decision on the proposed Maximum Allowable Revenue (MAR) for the 2014 DAU period (including a proposed WACC of 7.17 per cent, based on a debt margin of 2.72 per cent and an asset beta of 0.45, which implied an equity beta of 0.8).

On 22 December 2014, the Authority received 10 submissions from stakeholders on the MAR draft decision. Five submissions commented specifically on the QCA's proposed debt margin and/or asset/equity beta, and in March 2015, a further submission was received from the Queensland Resources Council (QRC).

2.2 Terms of Reference

The Authority has engaged Incenta to review and, in particular, to focus on the new arguments contained in the following submissions/papers:

- Aurizon Network (December, 2014) – *Aurizon Network response to Queensland Competition Authority's Draft Decision on Maximum Allowable Revenue*, including Chapter 10 of the submission and the following attached reports:
 - a. Attachment 2 – SFG Consulting Report 2 – Commentary on the systematic risk analysis of Aurizon Network by the Queensland Competition Authority – Report for Aurizon Network
 - b. Attachment 7 – The Brattle Group Report – Aurizon Network 2014 Draft Access Undertaking: Comments on Aspects of the WACC
- Anglo American (December, 2014) – *Response to the QCA Draft Decision on Aurizon Network's Maximum Allowable Revenue*

- BMA (December, 2014) – *Aurizon Network’s 2014 DAU – Queensland Competition Authority’s Draft Decision on Aurizon Network’s Maximum Allowable Revenue*
- QRC (December, 2014) – *QRC Submission to the QCA: Aurizon Network 2014 Draft Access Undertaking – Maximum Allowable Revenue*
- QRC (9 March, 2015) – *QRC Submission to the QCA*
- Vale (December, 2014) – *Aurizon Network’s 2014 Draft Access Undertaking (UT4) – Maximum Allowable Revenue Draft Decision.*

2.3 Outline of report

In addressing the terms of Reference we have considered each of the submissions listed above, and have categorised the various issues raised (in relation to the Incenta reports) into two main topics that can be grouped under the next two chapters:

- Cost of debt issues are considered in Chapter 3; and
- Cost of equity issues are reviewed in Chapter 4.

3. Debt risk premium

Aurizon Network’s submission claims to have uncovered a number of ‘errors in Incenta’s application of the PwC method’, and that correcting these results in a change in the debt risk premium from the range of 251 basis points (extrapolated Bloomberg method) to 272 basis points (econometric method) to a point estimate of 300 basis points based on an adjusted econometric method.

In this chapter, we have grouped the issues raised in submissions, have first presented the case(s) put by the stakeholders, and have then set out our response to the issues raised.

3.1 Sample bias

3.1.1 Issues raised by respondents

Debt risk premiums for BBB and BBB+ bonds are not statistically significantly different

Aurizon Network finds that the debt risk premiums of the BBB and BBB+ bonds are not statistically significantly different from one another, while the A- credit rated bonds have a statistically significantly lower average debt risk premium. In other words, Aurizon Network considers the assumption implicit in Incenta’s use of the pooled sample – that the difference in premium between a BBB+ and a A- bond is the same as between a BBB and BBB+ bond – is not correct.

According to Aurizon Network, this means that you cannot calculate the credit rating for the pooled sample as we have, because doing so would result in an understated credit rating for the sample. In Aurizon Network’s view this means that in order to estimate a valid debt risk premium it is necessary to:

- Include dummy variables in the regression allowing the data to find the difference between debt risk premiums across the A-, BBB+ and BBB credit rating bands; or
- Pool only the BBB and BBB+ bonds.

As shown in Table 3.1 below, Aurizon Network said that if a dummy variable is included to separately identify A- bonds, the coefficients representing BBB and BBB+ bonds together (all BBB credit rated bonds) would derive a 10 year BBB+ debt risk premium estimate of 300 basis points. Similarly, it also said that by excluding A- bonds from the regression analysis, and retaining a sample of undifferentiated BBB credit rated bonds (i.e. all BBB and BBB+ bonds), a 10 year BBB+ debt risk premium estimate of 299 basis points is obtained. These results are obtained because Aurizon Network considers BBB and BBB+ bonds to be equivalent.

Table 3.1: Aurizon Network Table 10.8 – Summary of DRP estimates based on Simple Portfolio Method

Methodology	Estimate	Delta to Incenta SP
Estimates based on Simple Portfolio Method		
Incenta (2013) - Simple Portfolio Method	2.72%	N/A
Aurizon Network - Simple Portfolio Method with A- Dummy Variable	3.00%	0.28%
Aurizon Network - Simple Portfolio Method excluding A- bonds	2.99%	0.27%

Source: Aurizon Network, (19 December, 2014), p. 183.

3.1.2 Incenta’s response

Inability to replicate Aurizon Network’s debt risk premium estimates using dummy variables

Table 3.2 displays the results Aurizon Network obtained by applying dummy variables for BBB rated bonds and A- rated bonds. The estimated 10 year BBB+ debt risk premium is approximately 3.00 per cent. However, when we apply the same method to the data that we used to estimate a 10 year BBB+ debt risk premium of 2.72 per cent, we obtain a different result, which is approximately 2.80 per cent (or 8 basis points higher than our original estimate). In other words, we cannot replicate Aurizon Network’s findings using the bond data that was used to obtain the debt risk premium estimate of 2.72 per cent.

Table 3.2: Regression results using dummy variables, debt risk premium – 20 days to 31 October, 2013, N=84

	Incenta			Aurizon Network		
	Coefficient	T-Stat	P value	Coefficient	T-Stat	P value
Intercept	1.641	11.189	4.89E-17	1.566	10.906	1.71E-17
Term	0.115	5.646	2.38E-07	0.143	7.147	3.71E-10
A- Dummy	-0.541	-4.462	2.63E-05	-0.526	-4.420	3.07E-05
BBB Dummy	0.005	0.042	0.966	0.012	0.103	0.91809
Est. 10 Yr BBB+	2.796			2.998		

Source: Aurizon Network, Bloomberg, UBS, Incenta analysis

Similarly, we cannot replicate Aurizon Network’s estimated 10 year debt risk premium of 2.99 per cent if only the 50 bonds rated BBB or BBB+ are pooled. We obtain an estimate of 2.82 per cent, which is close to the 2.80 per cent we obtain applying the dummy variables approach.

Table 3.3: Regression results using only BBB and BBB+ bonds, debt risk premium – 20 days to 31 October, 2013, N=50

	Incenta			Aurizon Network		
	Coefficient	T-Stat	P value	Coefficient	T-Stat	P value
Intercept	1.627	12.871	3.53E-17	1.590	12.962	2.72E-17
Term	0.119	4.920	1.06E-05	0.140	5.950	2.99E-07
Est. 10 Yr BBB+	2.818			2.987		

Source: Aurizon Network, Bloomberg, UBS, Incenta analysis

The impact of 4 DBCT bonds on the debt risk premium estimates

Our analysis suggests that Aurizon Network’s submission that the debt risk premiums of BBB and BBB+ bonds were not statistically significantly different during the averaging period up to 31 October, 2013, and that this differential is different to the differential between BBB+ and A- bonds, is due to the influence of 4 Dalrymple Bay Coal Terminal (DBCT) bonds,.

In our original report we provided a sensitivity that excluded the 4 DBCT BBB+ bonds from the analysis.²⁵ We tested excluding the DBCT bonds because there has been some controversy about whether these bonds are representative of BBB+ bonds, given that they were originally ‘credit wrapped’ AAA-rated bonds that had been downgraded during the global financial crisis.²⁶ When the 4 DBCT bonds were excluded, the estimate of the debt risk premium of a 10 year BBB+ bond reduced from 272 basis points to 264 basis points, but we recommended retaining the higher figure as the BBB+ estimate.

In addition, we note that if only the 18 BBB+ bonds (including the DBCT bonds) are employed in the regression, the estimated 10 year BBB+ debt risk premium is 274 basis points (i.e. only 2 basis points higher than if all 84 bonds are used). However, if the 4 DBCT bonds are excluded from the regression using only BBB+ rated bonds, the estimated 10 year BBB+ debt risk premium falls to 237 basis points. In other words, the evidence based on only BBB+ bonds is sensitive to a few DBCT bond observations, which have a specific characteristic (ex-credit wrapped).

Table 3.4 below shows that when the DBCT bonds are included the average net vertical difference of each debt risk premium value from the pooled sample debt risk premium regression line is 22.7 basis points for BBB bonds, and 18.7 basis points for BBB+ bonds. The BBB and BBB+ differentials are found not to be statistically significant. On the other hand, the debt risk premiums of the A- group of bonds are found on average to be 30.8 basis points below the BBB+ regression line, which is statistically significant at the 1 per cent level for a one-tail T-test.²⁷ In terms of statistical significance, these results are consistent with Aurizon Network’s findings.

²⁵ Incenta (November, 2013), p.28.

²⁶ It has been argued that these bonds were ‘tainted’ by their successive downgrade experience in the wake of the global financial crisis, and therefore attracted a higher yield than a typical BBB+ bond of the same term to maturity. We also note that Standard & Poor’s re-rated the 4 DBCT bonds from BBB+ to BBB on 30 July, 2014, approximately 9 months after our original report.

²⁷ A one-tail T-test is appropriate because theory suggests that for a given term, BBB bonds should attract a higher debt risk premium than BBB+ bonds, and that BBB+ bonds should attract a higher debt risk premium than A- bonds. We applied both the equal and unequal variance assumptions as we had no prior assumption on this issue.

Table 3.4: Relative differences from pooled sample regression line (basis points) for 20 days to 31 October, 2013

Credit rating	N	Including DBCT		N	Excluding DBCT	
BBB	32	22.7		32	22.7	
BBB+	18	18.7		14	0.8	
		Unequal Var.	Equal Var.		Unequal Var.	Equal Var.
T-statistic		-0.297	-0.316		-2.304	-2.037
Prob. - 1 tail		0.384	0.377		0.014	0.024
BBB+	18	18.7		14	0.8	
A-	34	-30.8		34	-30.8	
		Unequal Var.	Equal Var.		Unequal Var.	Equal Var.
T-statistic		3.832	4.219		3.100	2.820
Prob. - 1 tail		0.000	0.000		0.002	0.004

Source: Bloomberg, UBS, Incenta analysis

However, the right hand column of Table 3.3 shows the average debt risk premium differentials from the pooled sample regression line when the 4 DBCT bonds are excluded. We find that the average difference for BBB+ bonds is only 0.8 of a basis point, and that the BBB+ group is now statistically significantly different from the BBB bonds at better than the 3 per cent level. From this we conclude that Aurizon Network’s results are dependent on the inclusion of four observations that are questionable.

The fact that the debt risk premiums of the 14 non-DBCT BBB+ rated bonds are so well described by the pooled bond observations regression line (derived using all 84 bonds in the sample) gives us confidence that it provides the most appropriate estimate of the debt risk premium for an average BBB+ rated bond at a term of 10 years. While we have retained the four questionable (DBCT) bonds in our pooled sample, the utilisation of a large sample has effectively neutralised their impact.²⁸

Table 3.5 shows the results if the dummy variable regression approach is applied with the 4 DBCT bonds excluded, or treated as the BBB rated bonds they subsequently became. If the DBCT bonds are excluded the differential between BBB+ bonds (the intercept) and A- bonds is -33.7 basis points, while the differential between BBB+ rated and BBB rated bonds is 20.8 basis points. Moreover, the latter differential is statistically significant.²⁹ If DBCT bonds are included as BBB bonds the respective BBB+ differentials to A- and BBB rated bonds are even closer together: -33 basis points and 28.9 basis points respectively. This is further evidence that the assumption underlying PwC’s econometric method – that the differential between BBB+ bonds and A- bonds, and the differential between BBB+ and BBB bonds is approximately equal - is appropriate.

²⁸ Alternatively, we could have lowered the credit rating of the DBCT bonds from BBB+ to BBB in our analysis, which is what Standard & Poor’s did some 9 months later (on 30 July, 2014). We also note that the DBCT bonds problem does not arise in subsequent applications of the PwC econometric methodology (see, for example, Incenta, (May, 2015), *WACC parameters for GAWB Price Monitoring Investigation 2015-20 – Final Report*). In the pooled bonds framework applying a BBB credit rating to the 4 DBCT bonds would have changed the overall average weighting of all the bonds to be slightly closer to an average of BBB+ under the PwC weighting approach.

²⁹ That is, statistically significant at the 7.9 per cent level for a One-tail T-Test.

Table 3.5: Influence of DBCT bonds - Regression results using dummy variables, debt risk premium – 20 days to 31 October, 2013

	Incenta: excluding DBCT (N=80)			Incenta: DBCT as BBB (N=84)		
	Coefficient	T-Stat	P value	Coefficient	T-Stat	P value
Intercept	1.428	9.893	2.64E-15	1.405	9.731	3.24E-15
Term	0.118	5.728	1.93E-07	0.122	6.306	1.48E-08
A- Dummy	-0.337	-2.862	0.005	-0.330	-2.640	0.010
BBB Dummy	0.208	1.782	0.079	0.289	2.375	0.020
Est. 10 Yr BBB+	2.61			2.63		

Source: Bloomberg, UBS, Incenta analysis

Finally, we note that the 10 year BBB+ debt risk premium range estimated by excluding DBCT bonds or treating them as BBB bonds, 2.61 per cent to 2.63 per cent, is close to the 2.64 per cent that was estimated in our original report using the pooled regression method as a sensitivity with the DBCT bonds excluded. Our approach was to rely on the larger sample (with DBCT bonds included), which obtained a 10 year BBB+ debt risk premium estimate of 2.72 per cent.

PwC's weighting system

Sample size vs potential sample bias

The PwC method uses bonds on either side of the BBB+ credit rating band to estimate the debt risk premium for BBB+ bonds because this provides a much larger sample of bonds. It is generally found that only 15 to 20 BBB+ bonds satisfy the selection criteria, while there can be up to 80 or 90 bonds in the sample if BBB and A- bonds are included. Hence, PwC's weighting mechanism is a broad approximation, which is a high level cross-check of whether the sample is materially biased away from the target BBB+ ratings band.

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.³⁰ In these

³⁰ As discussed below, the small number of high yield BBB+ bonds were all issued by DBCT.

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.

Aurizon Network's alternative weighting proposal

Aurizon Network's submission has proposed that using the coefficients it obtained from its A-dummy and BBB dummy variables, it can construct an alternative weighting system. We disagree. The dummy variables that Aurizon Network identified relate only to the intercept term, and do not tell us what the relative predicted yields for BBB+, BBB and A- bonds are at 10 years. In any case, we have already shown that the results obtained from including dummy variables are sensitive to inclusion of 4 DBCT bonds as BBB+ bonds. These bonds have a significant distorting influence on the 18 BBB+ bonds applied in the dummy variable regression.

In summary, we consider that the pooled regression method using simple weights is a sound approach to overcome the problems inherent in small bond samples.

3.2 Incenta's extrapolated Bloomberg estimate of the debt risk premium

3.2.1 Issues raised by Aurizon Network

Incenta's Bloomberg 'paired bonds' estimate is an outlier

Aurizon Network submits that if corrections are made to the Simple Portfolio regression approach employed by Incenta, and if the alternative cost of debt method now applied by the Australian Energy Regulator were applied, Incenta's estimate of the debt risk premium at 31 October, 2013 appears to be 'a negative outlier'.

Table 3.6 below reproduces part of Table 10.8 from Aurizon Network's submission, which states that applying the AER's current method would increase the estimate of the debt risk premium to 360 basis points, which is 88 basis points higher than Incenta's econometric estimate. Aurizon Network submits that applying the AER's current method to estimate the debt risk premium for the 20 days to 31 October, 2015 would take the average of:

- The extrapolated 10 year debt risk premium estimated by reference to the Reserve Bank of Australia's (RBA method) 10 year BBB corporate yield estimate (391 basis points); and
- The 7 year Bloomberg BBB fair value yield estimate extrapolated to 10 years by applying the debt risk premium between 7 and 10 years implied by the RBA's method (328 basis points).

The QCA's final decision on the cost of debt derived an average RBA credit spread to CGS of 338 basis points (i.e. averaging the September and October 2013 RBA estimates). In light of these findings, Aurizon Network suggests that relative to Incenta's Bloomberg extrapolation (251 basis points), the Incenta estimate is a negative 'outlier' as shown in Table 3.5 below.

Table 3.6: Aurizon Network Table 10.8 – Summary of 10 year BBB+ debt risk premium estimates relative to the PwC econometric method (2.72 per cent)

Methodology	Estimate	Delta to Incenta SP
Bloomberg and RBA based estimates		
Incenta (2013) - paired Bonds Extrpolation of Bloomberg	2.51%	N/A
AER (2014) - RBA Extrapolation of Bloomberg	3.28%	0.56%
QCA (2014) - RBA BBB Non-financial Corporate Bond Yield	3.38%	0.66%
AER (2014) - Adjusted RBA Non-financial Corporate Bond Yield	3.91%	1.19%
AER (2014) - Combined Estimation	3.60%	0.88%

Source: Aurizon Network, (19 December, 2014), p. 183.

There are discrepancies in Incenta’s Bloomberg ‘paired bonds’ analysis

Aurizon Network also submitted that there are discrepancies in Incenta’s Bloomberg ‘paired bonds’ analysis. The first point relates to the disparate term relationships of the shorter and longer term bonds in each of the pairs (which were between less than one year and three years). Aurizon Network’s second concern relates to the quality of the data. That is, according to the PwC Bloomberg extrapolation method, the bond pairs used should be part of the wider sample of bonds used in the econometric analysis.³¹ However:

- The two CBA Property Fund bonds used in Incenta’s paired bonds analysis had terms of 6.15 years and 9.16 years, while the sample used in the econometric analysis did not include a CBA Property Fund bond with a term of 9.16 years; and
- The two GPT bonds used in Incenta’s paired bonds analysis had terms of 5.28 years and 8.83 years, while the sample used in the econometric analysis did not include a GPT bond with a term of 8.83 years.

If these two pairs were to be excluded from the sample, Aurizon Network submits that the extrapolated debt risk premium would have been 264 basis points instead of 251 basis points.

3.2.2 Incenta’s response

Incenta’s Bloomberg ‘paired bonds’ estimate is not an outlier

The Authority requested us to apply the two debt risk premium estimation methods that were recommended by PwC (2013), and are applied in its analysis of the cost of debt. The Bloomberg extrapolation is the second estimation method recommended by PwC, which the QCA uses as a cross-check against its primary method, the econometric estimation method.

We disagree with Aurizon Network’s view that Incenta’s Bloomberg extrapolation method produces a debt risk premium that is an outlier, even though on this occasion the estimated value was 2.51 per

³¹ PricewaterhouseCoopers (June, 2013), *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, p. 30.

cent relative to the 2.72 per cent obtained with the econometric method. As noted in our original report, the use of paired bonds to estimate the change in the debt risk premium with term has desirable methodological characteristics, since it holds constant all factors that might influence the debt risk premium, apart from term to maturity.³²

With respect to the method advocated by Aurizon Network to establish the cross check, we note there are two differences between it and the method we applied, namely:

- Whether the debt risk premium for BBB+ rated debt at 7 years under the alternative method is appropriate (Aurizon Network’s method in effect commences with a 7 year debt risk premium that is the average of the premium provided by the RBA and Bloomberg fair value curves, whereas the method we applied commenced only with the Bloomberg value), and
- Whether the extrapolation that is applied to convert the 7 year debt risk premium into a 10 year debt risk premium is appropriate (Aurizon Network’s method is to use the change in the debt risk premium between 7 and 10 years provided by the RBA fair value curve to extrapolate the debt risk premium from 7 to 10 years, whereas we used the ‘paired bonds’ method).

Of these two differences, it is the second difference (the choice of extrapolation method) that accounts for most of the gap between Aurizon Network and ourselves, which therefore focuses our attention on the annual change in the debt risk premium between 7 and 10 years that is implied under alternative methods. In Figure 3.1 below, we compare the annual change in the debt risk premium between 7 and 10 years obtained at the time of Aurizon Network’s averaging period with the results obtained at other times over the last four years by the RBA, AER, PwC, and Incenta.

Relative stability of estimation methods

The methods we compare are:

- [RBA method](#) – estimated by the RBA on a monthly basis (i.e. the annualised change in the debt risk premium calculated from the yields and effective terms published in the RBA’s Table F.3);
- [Bloomberg paired bonds extrapolation method](#) – estimated by PwC, the AER and Incenta; and
- [Econometric method](#) – estimated by PwC and Incenta.

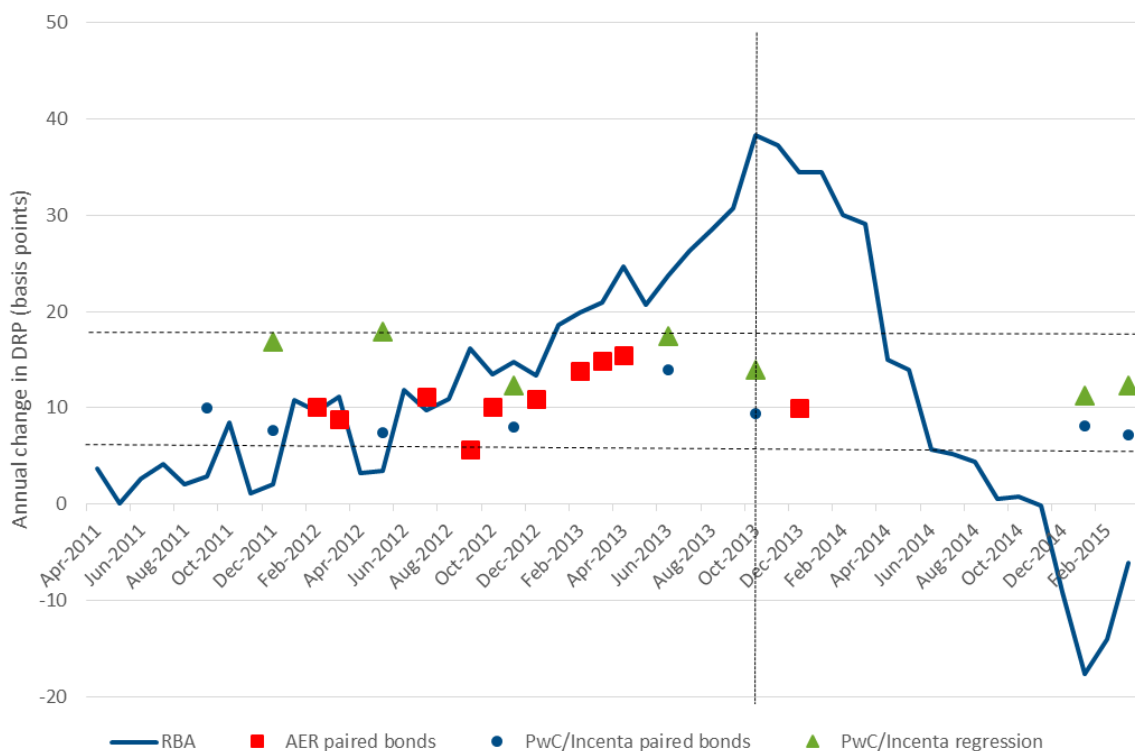
At the time of Aurizon Network’s averaging period (20 days to 31 October 2013), the RBA’s estimate of the annual debt risk premium change is shown to be the more likely to be an outlier. Over the past two years the 7 to 10 year debt risk premium estimated by the RBA’s method has been highly volatile, and at the time of Aurizon Network’s 31 October 2013 averaging period was estimating a peak debt risk premium of 38 basis points per annum (bppa) (i.e. a total extrapolation of 114 basis points from 7 to 10 years). Recently the RBA’s BBB debt risk premium estimate between 7 and 10 years has

³² Incenta (November, 2013), p.10.

become negative, and we note that it has been negative for approximately 14 per cent of the months since the start of the series in 2005.³³

By contrast, the annual change in the BBB+ debt risk premium from 7 to 10 years, as estimated by regression analysis and by the Bloomberg ‘paired bonds’ method (which was for a period applied in decisions by the AER) has been relatively stable. The econometric method applied by PwC and Incenta has resulted in a range of between 12.3 bppa and 17.9 bppa, while the paired bonds analysis applied by the AER, PwC and Incenta has ranged from 5.7 bppa to 15.5 bppa. The overall range for these two methods was 5.7 bppa to 17.9 bppa, which is shown to be considerably more stable than the –18 bppa to 38 bppa range identified using the RBA’s method.³⁴

Figure 3.1: Change in BBB debt risk premium (7 to 10 years) – RBA vs regression and paired bonds analysis (basis points per annum)



Source: RBA Table F.3, AER decisions, PwC and Incenta reports.

³³ The 7 to 10 year debt risk premium has been negative 14.2 per cent of the time from January 2005 to April, 2015, not counting 11 months in 2007-08 when the 7 year debt risk premium was not available. The annual change in the debt risk premium after 7 years was estimated by dividing the difference in the debt risk premiums for the effective terms corresponding to 7 and 10 years by the difference in the effective terms corresponding to 7 and 10 years.

³⁴ We would note, however, that the differences in the annual change in the debt risk premium between 7 and 10 years is not completely reflective of the implied debt risk premium under each methodology, since each methodology starts from a different 7 year debt risk premium point.

We note that as at 31 October, 2013 the 7 year debt risk premium estimated by each method were:

- Approximately 2.74 per cent using the RBA BBB fair value curve (this reflects the average yield reported for the September to October month ends – the RBA only reports month end figures);³⁵
- 2.37 per cent using Bloomberg (based on the BBB yield of 6.12 per cent for the 20 days to that date); and
- 2.31 per cent using the PwC econometric method (based on the BBB+ yield for the 20 days to that date).

Hence, in addition to an unusually high 7 to 10 year debt risk premium at 31 October, 2013, the RBA method was estimating a 7 year BBB debt risk premium that was already approximately 37 basis points higher than the yield Bloomberg was estimating, and approximately 43 basis points higher than the 7 year BBB+ yield estimated using the PwC econometric approach. We take comfort from the fact that the Bloomberg and econometric approaches yielded very similar results, and in contrast consider the RBA value to be out of step.

In a previous study undertaken by Incenta it was also found that the RBA's method had a tendency to volatility, however, over a longer period of time the bias (i.e. divergence from expected yields) was relatively low.³⁶ In other words, over or under-estimates of the expected BBB+ bond yield were cancelling out over time. This suggests that while it may be appropriate to apply the RBA method in the context of a trailing average approach to estimating the cost of debt (as the AER now does), it could result in significant inaccuracy if applied in the context of the 'on the day' approach that is practiced by the QCA.³⁷

In addition, we note that as at October, 2013, the AER did not have a policy of applying the RBA's BBB yield data to estimate the cost of debt for a benchmark 10 year term BBB+ bond. Its policy of providing equal weighting to the RBA data and the extrapolated Bloomberg method using the RBA's BBB debt risk premium change between 7 and 10 years was only introduced in 2014. It was introduced after an analysis of longer term performance of the RBA method, and was to be used in the context of a trailing average approach. Hence, it is not clear that if the AER were to estimate a spot debt risk premium, the AER would have applied its current policy at a time when the RBA method's implied annual change between 7 and 10 years was at the extraordinarily high level observed in October, 2013.

Conclusions

In summary, the evidence shows that over the past four years the paired bonds analysis finding of an annual rise of 9.4 basis points in the debt risk premium between 7 and 10 years, or a rise of 12.6 basis

³⁵ This approximation is the debt risk premium based on the annualised estimated yield for the 6.94 year effective term of the RBA bonds for the September and October 2013 month ends, and the annualised CGS yield at a term of 7 years averaged over the 20 business day period from 2 October, 2013, to 29 October 2013.

³⁶ Incenta (June, 2014), *Methodology for extrapolating the debt risk premium*, p.6.

³⁷ As noted above, we believe that the 'paired bonds' extrapolation method has desirable properties as a form of 'controlled experiment'.

points (based on the only BBB+ credit rated pair of bonds observed during the 31 October, 2013 averaging period), are both within the bounds of other estimates made by the AER, PwC and Incenta. Furthermore, at 31 October, 2013, the estimate obtained using the Bloomberg ‘paired bond’ method is not far from the 14 basis point per annum rise estimated using the econometric method.

Discrepancies in Incenta’s Bloomberg ‘paired bonds’ analysis

Disparate terms of bonds

Regarding disparate terms, we agree with Aurizon Network that terms (of the shorter and longer bonds) aligning with the 7 to 10 year target terms would be ideal. However, more closely aligned bonds could not be identified. We note that even the shortest term differential (for Sydney Airport) produced a 13.8 basis point per annum rise in the debt risk premium, which for BBB credit rated bonds is not inconsistent with the 12.6 basis points per annum observed for SP Ausnet.

Exclusion of two A- bonds

Aurizon Network is correct in noting that the two longer term A- credit rated bonds (Commonwealth Property Fund and General Property Trust) were not included in the regression analysis sample. This was because these two bonds did not have BGNs. The BGN is the ‘Bloomberg Generic Price’, which is Bloomberg’s ‘market consensus view’ of the yields that are supplied to it on a daily basis by financial institutions. It is a number that is subject to Bloomberg analyst judgement (i.e. it is not a mechanical formula). Bloomberg also supplies yield estimates for bonds based on its Bloomberg Valuation Service (BVAL), and in the period since the PwC (June, 2013) report was completed, Bloomberg’s emphasis has shifted over to BVAL. We acknowledge that the approach adopted in the case of Aurizon Network’s October 2013 averaging period was not consistent with the PwC (June, 2013) method. We also note that any future applications of the Bloomberg extrapolation using the ‘paired bonds’ method would need to use BVAL yields and would therefore include these bonds.³⁸

Alternative approaches

Table 3.7 below shows the 9.4 basis point per annum average that was applied in our previous report to obtain an extrapolated debt risk premium estimate of 251 basis points, as well as two alternative approaches. The alternatives include:

- Simply adopting the single BBB+ observation (SP Ausnet), which results in a 261 basis point estimate; and
- As Aurizon Network’s submission suggests, apply the average of the SP Ausnet bond and Sydney Airport bond (despite the short term differential of the latter), which results in a debt risk premium estimate of 263 basis points.³⁹

³⁸ However, the requirement to apply the Bloomberg extrapolation from 7 to 10 years has become redundant, since Bloomberg is now publishing a 10 year BBB fair value yield (although questions will remain about how representative this estimate is of a BBB+ yield).

³⁹ Aurizon Network submits that taking the average of the BBB and BBB+ bonds derives a debt risk premium of 264 basis points, however we derive an estimate of 263 basis points.

We also note, with reference to Figure 3.1 above, that annual debt risk premium rises of between 9.4 basis points and 13.2 basis points are all within the ranges of experience over the past four years (which has been a range of 5.7 bppa to 15.5 bppa).

Table 3.7: Paired bond analysis, 20 days to 31 October, 2013

Issue	Credit Rating	Term of short bond	Term of long bond	DRP of short bond	DRP of long bond	Basis points per annum	Adopt BBB+	Ave of BBB/BBB+
CBA Property Fund	A-	6.15	9.16	2.11	2.27	5.2		
GPT	A-	5.27	8.83	1.83	2.05	6.1		
SP Ausnet	BBB+	7.46	8.70	1.98	2.14	12.6		
Sydney Airport	BBB	8.09	8.98	3.39	3.51	13.8		
BPPA average						9.4	12.6	13.2
3 times bppa						28	38	40
Bloomberg 7 year DRP						223	223	223
Extrapolated						251	261	263

Source: Incenta (November, 2013), p. 30, and Incenta analysis

Conclusions

The Authority’s primary method is the econometric estimate, which is 2.72 per cent, and the extrapolated Bloomberg estimate using paired bonds is a cross-check. While we have shown that a debt risk premium estimate applying Aurizon Network’s suggestion of averaging the paired bond estimates for the available BBB and BBB+ bond pairs would result in a debt risk premium estimate of 2.63 per cent, and note this is still below the level of 2.72 per cent that has been adopted by the QCA on the basis of the econometric estimate.

3.2.3 Issue raised by QRC

QRC’s submission considers that it is preferable to rely on third party independent estimates of the debt risk premium, and prefers the use of Bloomberg, with no reference to the potential use of the RBA series. It considers that if the QCA is to rely on Incenta modelling, it should not accept Aurizon Network’s revised estimate without undertaking its own independent estimate.

3.2.4 Incenta’s response

The debt risk premium approach adopted by the QCA places primary reliance on the econometric method of PwC (2013), with Bloomberg acting as a cross-check. We note that third party independent estimates are not without their own issues. During the global financial crisis it was shown that Bloomberg fair value yield estimates were under-estimating BBB+ fair value yields.⁴⁰ Subsequently, the PwC (2013) report found that at some parts of the Bloomberg BBB fair value curve it over-estimated a BBB+ fair value yield.⁴¹

⁴⁰ PwC (November, 2009), *Victorian Distribution Businesses – Methodology to estimate the Debt Risk Premium*.

⁴¹ PwC (2013), p.67.

Regarding Aurizon Network’s revised estimates, the QCA has engaged Incenta to review them. These estimates range from:

- 264 basis points (revised paired bonds extrapolation); to
- 300 basis points for the revised econometric method; and
- 360 basis points applying the AER’s current method retrospectively.

We have shown that the 360 basis point estimate of the spot debt risk premium for the 20 days to 31 October, 2015 based on the AER’s current approach is not reliable, as this approach has been subject to extraordinarily wide fluctuations. The RBA method’s annual rise in the BBB debt risk premium between 7 and 10 years was at 38 basis points in October, 2013, as compared with an observed annual rise of between 13 and 14 basis points for BBB and BBB+ credit rated bonds that we used in the Bloomberg ‘paired bonds’ extrapolation method. With respect to its estimate of the 7 to 10 year debt risk premium, the RBA method has been found to be highly volatile over the past two years relative to the econometric and ‘paired bonds’ extrapolation methods. A previous analysis found that over a longer period the degree of bias (from expected values) of the RBA BBB bond yields was not large. As noted above, this implies that while the RBA method may be appropriate for applying a trailing average approach, since the over- and under-estimates cancel out over time, it is a method that should be avoided when applying the ‘on the day’ approach that is applied by the QCA.

3.2.5 Conclusion on debt risk premium

We have reviewed the submissions of Aurizon Network and other stakeholders on the debt risk premium, and remain of the view that the econometric estimate of 2.72 per cent contained in our earlier report is the best estimate of a 10 year BBB+ debt risk premium for the 20 business days to 31 October, 2013.

4. Cost of equity

Aurizon Network engaged SFG Consulting (SFG) and The Brattle Group to review Incenta’s advice on asset beta. Aurizon Network, SFG, and The Brattle Group submitted that it was:

- Inappropriate for Incenta and the Authority to completely ignore systematic risk evidence for rail and transport comparators, while focussing exclusively on regulated energy and water, a bulk commodity port (DBCT) and toll-roads; and,
- The pseudo-month beta estimation method applied by Incenta resulted in beta estimates that were biased downwards.

We consider these and other issues raised by stakeholders below.

4.1 Alleged inconsistencies in reasoning and choice of comparator companies

4.1.1 Issues raised by SFG, Aurizon Network and The Brattle Group

Incenta placed no reliance on evidence for railroads and other transport businesses

SFG’s submission states that Incenta’s (and the QCA’s) conclusions on beta are biased because there is ‘no single piece of quantitative evidence, relied upon by the QCA in estimating beta that relies in any way to any rail business.’ Instead, according to SFG’s submission, Incenta (and the QCA) rely ‘entirely upon quantitative evidence from businesses associated with ports, energy, water, and toll roads.’⁴²

Incenta included Grant Samuel’s beta estimate for DBCT but ignored its estimate for West Net Rail (now Brookfield Rail)

SFG submitted that Incenta’s report used an estimated asset beta of 0.35 for the Dalrymple Bay Coal Terminal (DBCT) as a lower bound estimate for Aurizon Network, which was the estimate of an independent expert, Grant Samuel. However, SFG points out that ‘the same independent expert, in the same report, made an estimate of the equity beta for West Net Rail (now Brookfield Rail) and arrived at an equity beta estimate of 1.0 to 1.1, assuming a gearing of only 20 to 25%’ (emphasis in original), but this estimate was ignored by Incenta. While qualifying that it was not suggesting that WestNet Rail, or any other firm, is a perfect comparator for Aurizon Network, SFG considered that it has ‘some relevance’ (emphasis in original).

Standard & Poor’s considers WestNet Rail to be a comparator for Aurizon Network

SFG notes that:⁴³

⁴² SFG Consulting (21 November, 2014), p.4.

⁴³ SFG (21 November, 2014), p. 4.

...Standard and Poor's relies upon the same WA rail network in its analysis of the Central Queensland Coal Network, and also considers other transportation businesses, but does not consider energy networks.

Incenta claims that regulation of Class 1 railroads is not comparable to Aurizon Network but has no evidence that form of regulation affects beta

SFG's submission proposes that Incenta excluded Class 1 railroads on grounds that the form of regulation is not comparable to that applied to Aurizon Network, 'despite the lack of any empirical evidence showing any reliable connection between equity beta estimates and the form of regulation'.

Incenta's upper-bound beta would be higher if Transurban was omitted from the toll-road sample

In addition, The Brattle Group has submitted that the cash flow to capital expenditure ratio (CF/capex) of Transurban identifies it as an outlier relative to other toll-roads, and since Transurban's beta estimate is relatively low, its exclusion from this industry sample would markedly increase the beta estimate for toll-roads. This would raise the 'upper-bound' that Incenta has identified.

4.1.2 Incenta's response

Incenta placed no reliance on evidence for railroads and other transport businesses

SFG is incorrect to infer that in our analysis (which was referred to by the QCA) there was 'no single piece of quantitative evidence' that relied 'in any way to any rail business.' In our original report we presented a large array of quantitative information relating to the financial and market characteristics of a significant number of Class 1 railroads, airports, and toll-roads, which are all components of the transport sector. Our analysis carefully assessed the data for Class 1 railroads and the other transport industries and compared this with Aurizon Network's characteristics. Therefore, SFG is not correct in claiming that our analysis had not considered the evidence relating to Class 1 railroads or other transport companies. We considered that evidence very carefully in relation to every factor raised in the first principles analysis and found that Aurizon Network's systematic risk characteristics were very different to Class 1 railroads, but in many respects similar to those of regulated energy and water businesses.

Incenta included Grant Samuel's beta estimate for DBCT but ignored its estimate for West Net Rail (now Brookfield Rail)

SFG appears to be under the misconception that Incenta's reference to Grant Samuel's 0.35 estimate of DBCT's asset beta as a lower bound, and the empirically derived asset beta of toll-roads (0.49) as an upper bound estimate were dominating influences in our determination of an asset beta of 0.42 for Aurizon Network. This was not the case, even though, coincidentally, averaging the lower and upper bound estimates gave an average asset beta of 0.42. Instead, our asset beta estimate of 0.42 was primarily influenced by the empirical estimates for a large group of regulated energy and water sector businesses from around the world. We placed greater reliance on those empirical benchmarks and comparator groups because we had determined through our first principles analysis that the financial characteristics of regulated energy and water businesses are closer to those of Aurizon Network, notwithstanding their physical differences.

Having said that, we were, and continue to be, of the view that WestNet Rail is not a relevant comparator for Aurizon Network owing to differences in their fundamental characteristics, most importantly the nature of the traffic that is carried, the contractual arrangements, and the regulatory framework. Grant Samuel's report supports and illustrates the principle that we have depended on, which is that in the absence of direct comparators it is more important to look through the physical characteristics of the operations to the economic fundamentals, and focus on how the cash flows are likely to be influenced by systematic risk factors. Grant Samuel's expert report gave no weight to the fact that DBCT is a port, and the UK ports owned by Prime Infrastructure were also ports. This fact was highlighted in our previous report, but was not commented upon by SFG. In our previous report we noted:⁴⁴

That is, Grant Samuel could not find close comparators for DBCT, and made only passing reference to the Asciano Group (equity beta of 1.33),⁴⁵ but this did not influence its choice of a much lower beta for DBCT. Despite DBCT being a port, Grant Samuel did not refer to the ports comparator group that it used to assess the beta of Prime's Euroports business (including Hamberger Hafen, Forth Ports and Eurokai KGnA), as these were not deemed to be appropriate comparators for DBCT (a regulated coal port terminal).⁴⁶ Aurizon Network is part of the same coal supply chain as DBCT, and the two assets are regulated in a similar manner (i.e. building block approach with revenue-caps administered by the QCA).

Rather than rely on the much higher beta observed for general cargo ports, which are not regulated in the same way and whose traffic and revenues are more sensitive to the economic cycle, Grant Samuel relied on the fact that DBCT is regulated, and that this implies a lower beta. It concluded that DBCT's asset beta was 0.35 (if a Conine transformation and a debt beta of 0.12 is assumed), noting that:⁴⁷

While this appears low, none of the other listed ports are regulated and in Grant Samuel's view, the regulated nature of the asset (and the certainty of its cash flows) warrants a lower beta.

In other words, for Grant Samuel the most important characteristic of DBCT was its regulation and the certainty of its cash flows, which made comparison with European container ports irrelevant. None of the European container port data was applied by Grant Samuel in estimating DBCT's asset beta, and only passing reference was made to Asciano's equity beta of 1.33. Apart from the issue of DBCT's regulation, there was relatively little discussion by Grant Samuel as to why it had not considered or relied on any data relating to European container ports when estimating DBCT's asset beta.

Grant Samuel's assessment of WestNet Rail applied a higher asset beta than the asset beta of toll-roads, the latter of which we considered to have closer resemblance to the characteristics of Aurizon Network than WestNet Rail. Grant Samuel also put WestNet Rail into a different sectoral category to DBCT. On page 36 of its analysis, Grant Samuel included a table summarising 'Brookfield

⁴⁴ Incenta (9 December, 2013), p. 28.

⁴⁵ Presumably, Asciano was referenced as it has cargo port operations, but Grant Samuel did not infer that its high equity beta was appropriate to apply to DBCT.

⁴⁶ Since Grant Samuel emphasised the regulated nature of DBCT, this characteristic set it apart from the other ports, which deal with general cargoes.

⁴⁷ Grant Samuel (24 September, 2010), Appendix 1, p.10.

Infrastructure – Asset Portfolio at 30 June 2010’, which grouped DBCT and Powerco (a regulated energy business in New Zealand) together in the sectoral category ‘Utilities – Australasia’, while WestNet Rail was placed in a separate sector titled ‘Fee for Service – Australasia’. This suggests that Grant Samuel believed that Powerco (regulated energy) was a closer comparator for DBCT (regulated coal port) than WestNet Rail.

In conclusion, we did consider Grant Samuel’s assessment of the asset beta of WestNet Rail but after consideration came to the view that WestNet Rail is not a relevant comparator to Aurizon Network.

Risk assessment by Standard & Poor’s

With respect to SFG’s observation that Standard & Poor’s analysis of the Central Queensland Coal Network ‘considers other transportation businesses, but does not consider energy networks’, we note that Standard & Poor’s is concerned with credit risk, and not with systematic risk (i.e. beta risk). We acknowledged in our previous report on the benchmark credit rating and cost of debt that:⁴⁸

...Standard & Poor’s appears to consider that Aurizon Network is subject to greater fundamental credit risk exposure than the regulated energy networks.

Compared with energy networks, this greater credit risk was seen to be due to Aurizon Network’s narrower customer base and its exposure to the global competitiveness of the Queensland export coal industry. However, credit risk does not necessarily translate to greater beta risk if the factors underlying the credit risk are not systematic in relation to market returns.⁴⁹ We have not seen evidence that the factors that could undermine the competitiveness of the Queensland coal industry are systematically related to the performance of the Australian market.

Incenta claims Class 1 regulation is not comparable to Aurizon Network but has no evidence that form of regulation affects beta

SFG is correct in concluding that in our previous report we found no material difference in the asset betas of cost-based regulated firms depending on the form of cost-based regulation applied. However, the ‘form of regulation’ that was being considered in that analysis related to price regulation compared with revenue regulation, and incentive regulation compared with rate of return regulation. As was explained in our previous report, Class 1 railroads are subject to neither of these regulatory approaches, and therefore there is no inconsistency in the logic that we applied in our previous report. In that report we found that the weak form of regulation applied to Class 1 railroads provided a non-binding constraint, and provided no revenue or price protection that are characteristic of cost-based regulation, nor were these railways protected by virtue of market power or the high economic value of their services.⁵⁰ For example, at the time of the global financial crisis neither regulation nor market position provided Class 1 railroads with any level of protection of their cash flows, which was shown to have been impacted very heavily and negatively.

⁴⁸ Incenta (November, 2013), p.19.

⁴⁹ In technical terms, credit risk assessments are principally concerned with the variance of net cash flows, whereas beta is affected by the covariance of cash flows with the market.

⁵⁰ Incenta (9 December, 2013), p.33.

Incenta's upper-bound beta would be higher if Transurban was omitted from the toll-road sample

The Brattle Group's contention that with respect to its capital expenditure ratio Transurban is an outlier in the toll-road sample is questionable, since its analysis:

- Calculates the CF/Capex ratio only for the year 2014, which lies outside of the period of our asset beta estimates (which was from 2003 to 2013);
- Relies on equity beta rather than asset beta;
- Includes only 4 firms (including Transurban) out of the 7 firms in our toll-roads sample; and
- Omits data for one of these toll-roads (Gruppe Eurotunnel SA, or 'Gruppe') for the critical CF/capex ratio, so that the actual comparison of CF/capex ratios is done based on only 3 firms.⁵¹

As shown in Table 4.1 below, for the period 2003 to 2013 the CF/capex ratio for Gruppe was quite similar to Transurban - at 6.851 and 7.367 respectively, both were much higher than for the remaining 5 firms. If both Transurban and Gruppe were to be considered 'outliers' on the basis of this ratio, and both were to be excluded, the average (median) asset beta for the remaining toll-roads would be 0.51 (0.49), which is similar to the original sample (0.49 and (0.49) respectively as shown below).

A broader view of investing activity is achieved by calculating the ratio of operating cash flow to cash flow from investing (CF/CF from investing, which includes capex). With respect to this metric Transurban is positioned in the middle of the toll-road industry group, while Gruppe is still significantly higher than all other firms in the group. However, if Gruppe alone were to be excluded from the toll-road group, the average (median) asset beta would remain at 0.49 (0.49). That is, there would be no change in the average (median) asset beta estimate for toll-roads.

Table 4.1: Toll-roads sample: median operating cash flow to capex and cash flow from investing (2003-2013)

Name	Oper. Cash Flow / Capex	Oper. Cash Flow / Cash Flow from investing
Gruppe Eurotunnel SA	6.851	6.357
Atlandia SpA	1.122	1.165
Societa Iniziative Autostradali e Servizi SpA	1.281	1.082
Brisa Auto-Estradas de Portugal SA	3.144	1.074
Transurban Group	7.367	0.945
ASTM SPA	1.288	0.891
Abertis Infraestructuras SA	2.064	0.767

Source: Bloomberg

Based on the more comprehensive data that we have reviewed, we conclude that there is no support for The Brattle Group's contention that Transurban is an 'outlier' that should be excluded from the toll-roads industry group. However, even if Transurban were to be excluded, the impact on the

⁵¹ In relation to this last point, The Brattle Group said that data for the CF/capex ratio was not available for Gruppe, but we found that it is available in Bloomberg.

median toll-roads asset beta would be to raise it marginally from 0.49 to 0.50 (and the mean asset beta would rise from 0.49 to 0.51). In any case, we have never viewed toll-roads as an appropriate comparator for Aurizon Network, but rather considered that they are exposed to greater systematic risk and so would be expected to have a higher asset beta. To this end, in our original report we identified toll-roads as an industry providing a likely upper bound to the range of asset betas for Aurizon Network. That is, we would expect the asset beta of Aurizon Network to be less than the asset beta of toll-roads, which we have estimated at 0.49.

4.2 Previous regulatory decisions

4.2.1 Issues raised by Aurizon Network and the Brattle Group

Aurizon Network's submission notes that when the Economic Regulatory Authority of Western Australia (ERAWA) was setting prices for the Public Transport Authority (PTA) and WestNet Rail (now Brookfield Rail) it relied on advice that contradicted the approach adopted by Incenta in the following ways:⁵²

- Mature toll-roads were used as a comparator for the PTA, which Aurizon Network believes has less systematic risk than Aurizon Network; and
- Railroads and transport comparators were relied upon when determining an asset beta of 0.60 for WestNet Rail, which converted to an equity beta estimate of 0.92 at 35 per cent gearing. In contrast Incenta's analysis completely ignored the relevance of Class 1 railroads and other transport businesses. On page 196 of its submission Aurizon Network noted that its adviser specifically looked at the differences between WestNet Rail and US Class 1 railroads and thought that these might:

...overstate beta values for the freight rail system in Western Australia for reasons that the comparator businesses considered for this study would have a greater proportion of revenues derived from intermodal (container) traffic, which would generally be expected to have higher levels of non-diversifiable risk (and higher beta values) than the freight rail system in Western Australia, which has a greater proportion of revenues from bulk transport of grain and mineral products. Lower beta values of perhaps in the range of 0.50 to 0.60 (corresponding to equity beta values of 0.77 to 0.92) may be more appropriately determined for the freight rail system in Western Australia, and would be consistent with recent regulatory precedent.

In addition, The Brattle Group submits that some weight should be placed on Canadian railroads as comparators for Aurizon Network owing to the practice of the Canadian Transportation Agency (CTA):

... their regulated services consist of western grain and interswitching with the regulated cost of capital being determined for western grain. Thus the regulatory regime is similar in that the CTA sets the allowed return on equity for a single raw material... We noted

⁵² ACG (2007), *Railways (Access) Code 2000: Weighted Average Cost of capital: 2008 WACC Determinations*.

that the Canadian Transportation Agency uses the beta estimate for the Canadian railroads to determine the cost of capital for Western grain and interswitching (and a few other purposes).

4.2.2 Incenta’s response

Mature toll-roads as a comparator for the PTA, which has less systematic risk than Aurizon Network

It is true that the ERAWA’s adviser considered ‘mature toll-road companies’ to be a comparator for Perth’s PTA. We also agree with Aurizon Network that the PTA should have less systematic risk than Aurizon Network based on our knowledge of these businesses. However, we disagree with the contention that mature toll-road companies are an ‘appropriate comparator’ for Perth’s PTA. No detailed first principles analysis of the relative systematic risk characteristics of Perth’s PTA and mature toll-roads was undertaken to establish that this was the case.

Based on our own first principles analysis, we consider that if such an analysis had been undertaken, it would have concluded that since toll-roads are not regulated on a cost-of-service basis and are more vulnerable to economic cycles than is the PTA, they are not an appropriate comparator for the PTA. In any event, we note that the asset beta of toll-road companies estimated in 2007 was very low, as it caused the ERAWA to adopt an asset beta of 0.30 (Harris and Pringle, with a zero debt beta). At the time this was below the asset beta range being applied by regulators to the regulated energy networks (which was 0.40 using the same delivering method).⁵³

Reliance on railroads and transport comparators to estimate the beta of WestNet Rail

We consider that WestNet Rail is quite different to Aurizon Network, and hence the fact that Class 1 railroads and other transport companies were used as comparators for it is not relevant to Aurizon Network. In the circumstances of WestNet Rail there may well have been justification to place some reliance on Class 1 railroads and other transport companies, although we note that the asset beta adopted was lower than the asset beta of Class 1 railroads.

Practice of the Canadian Transport Agency

When we wrote our original report we were aware that the CTA had applied a beta estimated from the Canadian railroads to regulated wheat traffic.⁵⁴ The CTA’s approach of applying a beta based on the observed betas of the two listed Canadian railroads was criticised by the State of Manitoba, which noted that in 2009 only 6.3 per cent of Canadian National’s, and 10.8 per cent of Canadian Pacific’s overall revenue was from grain traffic. In addition, it said that:⁵⁵

The carriage of grain is a risk-reducing factor for the railways for two reasons. First, the railways have a virtual monopoly over the long-distance carriage of Canadian grain, which reduces the risk of transporting this commodity relative to most of the rest of the railways’ traffic... The second reason that grain transportation is less risky

⁵³ That is, reflecting an equity beta of 1.0 at a benchmark gearing of 60 per cent (Harris and Pringle, with a zero debt beta).

⁵⁴ Incenta (9 December, 2013), p.36.

⁵⁵ Manitoba, (undated), *Comments on the Cost of Capital Methodology Used by the Canadian Transportation Agency*, pp.2-3, and pp.12-13.

is that the volume of grain is not tied to the general economy, as with other commodities and merchandise that are transported by rail.

We agree with this assessment. For example, during the global financial crisis Manitoba observed that the carriage of grain actually increased while other traffic reduced significantly, which aligns with the findings in our original report.⁵⁶ We found that Canadian rail movements in agriculture declined by only 1.6 per cent between 2008 and 2009 (the global financial crisis), while coal declined 21.9 per cent, automotive traffic declined 31.2 per cent and intermodal declined 20.6 per cent. We consider this evidence to be indicative of higher systematic risk for the non-agricultural traffic of the Canadian railroads. However, the Brattle Group’s report did not comment on the findings that all Canadian traffic components except agriculture (which is predominantly grain) are relatively sensitive to economic conditions. Nor did The Brattle Group comment on the fact that these components that appear to have a strong relationship to the market (and hence generate a relatively high systematic risk) account for close to 90 per cent of the total traffic of the Canadian railroads. These findings make it inappropriate to apply the beta of Canadian railroads to estimate the beta of regulated grain traffic, and also inappropriate to apply the beta of Canadian railroads as a comparator for Aurizon Network, which is subject to cost-based regulation.

4.3 Systematic risk impact of revenue cap regulation

4.3.1 Issues raised by Aurizon Network, The Brattle Group and SFG

Aurizon Network submits that revenue cap regulation does not guarantee revenue will not fluctuate with demand, and The Brattle Group provides evidence that Aurizon Network’s revenues fluctuate more than those of US Class 1 railroads, implying that it has greater risk.

According to SFG, the order in which Incenta processes information affects the result. It argues that if industry characteristics had been considered first by Incenta, railroad businesses would have been retained as comparators because they are the most comparable to Aurizon Network in their operations. Instead, Incenta’s analysis commences with a consideration of the regulated nature of Aurizon Network’s operations, but then discards Class 1 railroads and other transport businesses as irrelevant comparators. As a result, these businesses are not given further consideration.

4.3.2 Incenta’s response

Revenue cap regulation and cash flow volatility

Our previous report did not propose that due to revenue cap regulation, Aurizon Network’s revenue does not fluctuate. It is inevitable that even with a revenue cap there will be fluctuations in cash flow in order to substantially reduce the fluctuation of revenue in NPV terms: revenue is adjusted so that shortfalls or excessive revenues are returned to provide the anticipated NPV neutral revenue outcome. However, the more relevant feature is that any ‘unders’ and ‘overs’ are structured to substantially reduce the fluctuation of revenue in NPV terms.

⁵⁶ Manitoba (undated), p.13.

For beta analysis the issue is whether the revenue fluctuation is related to movements in the market / economy. Therefore the volatility measure that has been used by The Brattle Group is not appropriate, since it relates to absolute volatility and does not take account of the fact that a significant jump in the level of Aurizon Network’s capital expenditure approved by the regulator will result in an increase in regulated revenue at a time of negative market returns.⁵⁷ That is, the ‘volatility’ measured by The Brattle Group reflects the increase in revenues following regulator-approved growth in assets, and was not causally related to market movements. What really matters for beta is the covariance between shareholder returns and returns in the market.

The order of analysis – regulation vs industry

Turning to SFG’s submission about the order of consideration of factors, we did not consider the regulation characteristic first, and then automatically reject all comparators that were not regulated businesses. Instead, we considered a number of industries with some characteristics that are held in common with Aurizon Network:⁵⁸

- Regulated (energy networks, water)
- Infrastructure (energy, water, toll-roads, US Class 1 railroads)
- Network (Energy networks, water, US Class 1 railroads), and
- Coal mining (coal mining)

We then compared the characteristics of firms in these industries to Aurizon Network’s characteristics using a first principles analysis. Our first principles analysis paid particular attention to the Class 1 railroads, as Aurizon Network and its adviser SFG had proposed these as reasonable comparators for Aurizon Network’s systematic risk. We showed that in every case, the financial / systematic risk characteristics of Aurizon Network were closer to regulated energy and water businesses than to the other industry sectors, including Class 1 railroads. On the basis of this analysis, which considered all of the characteristics of all of the industry sectors, we concluded that only the regulated energy and water sectors had systematic risk characteristics that were similar enough to Aurizon Network to include them as comparators.

4.4 Duration of contracts for Class 1 railroads

4.4.1 Issues raised by Aurizon Network

Aurizon Network submits that the Authority should discount Incenta’s statement that the contracts of US Class 1 railroads generally last only 1 to 3 years, as this statement was not attributed to a particular North American analyst.

⁵⁷ We say ‘theoretically negative’ because although there was a negative co-variance on this occasion, there was no causal relationship between the state of the market and Aurizon Network’s returns (i.e. it was coincidental).

⁵⁸ Incenta (9 December, 2013), p.27.

4.4.2 Incenta’s response

We have been in contact with Mr John L. Barnes III, Managing Director, Royal Bank of Canada, Capital Markets: Rails and LTLs in New York, who covers the North American Class 1 railroads, and is a leading market practitioner. He has confirmed to us that our understanding of the typical contract arrangements for Class 1 railroads with their customers are as follows:

- Contracts for most traffic types are for 1 to 3 years; and
- Contracts for haulage of coal are for terms of up to 5 years.

These are the same terms that we reported in our earlier report.

4.5 Aurizon Network’s relative market power

4.5.1 Issues raised by Aurizon Network

Aurizon Network submits that Class 1 railroads have similar market power to Aurizon Network because coal shipment shares have not changed over time, captive shipping accounts for 37 per cent of revenue, and ‘effective competition’ accounts for 53 per cent of Class 1 revenues. Aurizon Network quotes from its own earlier submission:⁵⁹

The presence of market power with significant price flexibility across a diverse traffic mix would suggest that US Class 1 railroads have the ability to partially insulate their free cash flow from changes in demand.

Aurizon Network’s submission does not agree with Incenta that as a result of Aurizon Network having greater market power it should be expected to have a lower beta. Having provided a reference to an academic study proposing that a negative relationship between market power and beta is not supported, Aurizon Network concludes:⁶⁰

As such, the conclusion by Incenta that Aurizon Network should have a lower beta by the sole reason that it exhibits more market power than the US Class 1 railroads is less than robust.

4.5.2 Incenta’s response

In our original report we did not propose that market power alone (i.e. as a ‘sole reason’) would result in a lower asset beta. In a downturn such as the global financial crisis of 2008-09, if Class 1 railroads had market power in the delivery of motor vehicles it would not have assisted them if motor vehicle demand suddenly fell significantly (as it did) because these are not essential goods. By contrast, as we emphasised in our original report, Aurizon Network has a combination of market power and a strong economic position due to the economics of the Queensland coal industry and the essential nature of

⁵⁹ Aurizon Network (2014a), *A Comparator Analysis of Aurizon Network’s Commercial and Regulatory Risks*, p.22.

⁶⁰ Aurizon Network (2014b), p.204.

the product carried. Even in the absence of regulation or long term contracting, these factors would result in a relatively lower asset beta compared with a business carrying motor vehicles (i.e. Class 1 railroads). However, as was emphasised in a number of places in our original report, the fact that Aurizon Network is regulated, has a monopoly position in Queensland, and Queensland coal has a strong economic position in the global market, and supplies an essential product, together indicate that a lower asset beta should be expected.

Aurizon Network has not provided convincing evidence that Class 1 railroads and Aurizon Network have similar levels of market power. If they did, we would expect that Class 1 railroads would be likely to be regulated in a manner resembling the regulation that is applied to Canadian grain traffic. As discussed in our previous report, the light-handed regulation that is applied to Class 1 railroads is neither a constraining nor a supporting factor in relation to their cash flows.

4.6 Academic studies of the influence of regulation on beta

4.6.1 Issues raised by Aurizon Network

Aurizon Network submits that Incenta’s position that regulation is the dominant factor determining its lower beta is contradicted by academic studies, where many studies find that there is no change in beta due to regulation, or even an increase in beta due to regulation.

4.6.2 Incenta’s response

Aurizon Network provides a table (Table 10.17) which divides empirical studies testing the Peltzman ‘buffering hypothesis’ into three categories:

- Regulation caused a decrease in beta (9 studies);
- There was no discernible trend in beta due to regulation (8 studies); and
- Regulation caused an increase in beta (3 studies).

We note that all 20 of the academic studies listed in the table were drawn from the Binder and Norton (1999) study, but Aurizon Network did not include in this table the results of the latest Binder and Norton study, which strongly supported the ‘buffering hypothesis’:⁶¹

After controlling for other relevant factors, including demand uncertainty facing the firm, we find (consistent with the Peltzman theory) that electricity utility betas decrease as regulation becomes more severe.

More fundamentally, many of the studies referenced by Binder and Norton, and displayed in Aurizon Network’s table, do not examine beta relative to regulation, but are ‘event studies’ that examine whether there is a change in shareholder wealth consequent to a change in regulation. ‘Event studies’ are often criticised due to the confounding issue of the market expecting regulatory changes to be

⁶¹ Binder, J.J. and S.W. Norton (1999), ‘Regulation, Profit Variability and Beta,’ *Journal of Regulatory Economics*, Vol. 15, pp. 249-265.

introduced before their actual introduction. The Binder and Norton list includes a 1984 study by Davidson, Chandy and Walker titled, ‘The Stock Market Effects of Airline Deregulation’. This was an event study that found contradictory results in relation to beta around the time of deregulation. However, the authors noted that an earlier study had found that the systematic risk of 12 airlines studied had increased while deregulation was being debated.⁶² That earlier study and others are not listed in Aurizon Network’s table.

In any event, a majority of the studies listed by Binder and Norton did not address the issue posed in our previous report, which proposed that the presence of cost-based regulation is likely to result in a lower asset beta, other things being equal. This is a difficult question to address empirically, since there are relatively few industries that are regulated in that manner, and these were either regulated for a long time (as in the United States), or regulated from their commencement as listed businesses (as in the UK and Australia). In addition, firms that are subject to regulation generally have the characteristics of a monopoly position in an economically critical or essential activity, and would be expected to have a relatively low beta even in the absence of formal cost-based regulation.

4.7 Aurizon Network’s relative growth option risk

4.7.1 Issues raised by Aurizon Network

Aurizon Network submits that Incenta’s analysis of growth options, as part of its first principles analysis, was flawed since US Class 1 railroads are entering a long term growth phase and a significant part of this capital expenditure will be funded by the US Government:⁶³

Given these observations on the future investment in Class 1 railroads, in contrast to the Incenta’s anecdotes of investment since the GFC, it could again be concluded that on the issue of growth options, the risk profile of Aurizon Network is greater than the US Class 1 railroads, as Aurizon no longer has a call on government funding.

4.7.2 Incenta’s response

In our original report we made the point that Aurizon Network was able to undertake investments in the midst of a financial crisis owing to the cost-based regulatory framework that it operates within. On the other side of this coin is the fact that cost-based regulation will minimise any effect of growth options on systematic risk, because the returns from new investments are subject to regulatory control. The point that we were making is that while differential growth options might be a reason for the systematic risk of unregulated businesses (like Class 1 railroads) to be higher or lower, Aurizon Network’s systematic risk is unlikely to be affected by growth options. Aurizon Network’s submission appears to suggest that Class 1 railroads have less risk than Aurizon Network because of the US Government’s willingness to ‘bankroll investment’, but has provided no evidence to support this proposition.

⁶² Cavarra, L.A., R.D. Stover, and B.J. Allen (1981), ‘The Capital Market Effects of Airline Deregulation’, *Transport Journal*, Vol. 20, Spring, pp.73-78.

⁶³ Aurizon Network (19 December, 2014), p.207.

4.8 Aurizon Network’s relative operating leverage

4.8.1 Issues raised by Aurizon Network

Aurizon Network submits that some of the operating leverage indicators estimated by Incenta were likely to have been based on regulatory cash flows and not real cash flows.⁶⁴

While we agree with the derivation of the opex/assets ratio for Aurizon Network in Table 3.4 of the Incenta report, we are more uncertain on the other reported metrics, as they are most likely derived from regulatory cash flows and not real cash flows or earnings.

In its Table 10.19, Aurizon Network provides a calculation of ‘derived operating leverage’ (DOL), which averages 5.71 and ‘is much greater than Incenta’s estimate of 1.01.’ For the period 2008/09 to 2011/12, 5.71 is the average of the change in EBIT divided by the change in sales (net tonnes). This is the same point that was made by Aurizon Network in an earlier submission.⁶⁵

Aurizon Network also submitted that two of Incenta’s DOL proxy estimates for US Class 1 railroads will be substantially overstated ‘as they do not take into account the large proportion of variable costs (i.e. fuel for train operations)’.⁶⁶ Aurizon Network noted that while Incenta calculated an opex/assets ratio of 8.4 per cent for Aurizon Network, the same ratio for Australian electricity transmission businesses was only 3.1 per cent, which implies that the operating leverage of Aurizon Network is actually much higher than for regulated energy businesses.

4.8.2 Incenta’s response

Estimation of the Degree of Operating Leverage

In estimating the operating leverage of Aurizon Network, we have not used ‘regulatory cash flows and not real cash flows or earnings,’ as suggested by Aurizon Network’s submission. Table 4.2 shows our calculation of Aurizon Network’s operating leverage based on the Inverse of the EBIT Margin. The numbers used for EBIT align perfectly with those used in Aurizon Network’s Table 10.19.

⁶⁴ Aurizon Network (19 December, 2014), p.207.

⁶⁵ Aurizon Network (20 January, 2014), *A Comparator Analysis of Aurizon Network’s Commercial and Regulatory Risks*, pp.25-26.

⁶⁶ Aurizon Network (19 December, 2004), p.208.

Table 4.2: Aurizon Network – Operating leverage (Inverse of EBIT Margin)

	2008/09	2009/10	2010/11	2011/12	Median
Revenue (\$,000)	489,966	694,154	698,326	731,836	696,240
EBIT (\$,000)	191,628	279,669	241,717	283,037	260,693
EBIT Margin	0.391	0.403	0.346	0.387	0.389
Inverse EBIT Margin	2.56	2.48	2.89	2.59	2.57

Source: QCA Note: Revenue is 'Coal Traffic Access and Electricity Charges' comprising AT1, AT2, AT3, AT4, AT5, and AT6/EC.

Having calculated its DOL number of 5.71 for its own operations, Aurizon Network concluded that this is much greater than the 1.01 that was reported in Incenta's Table 3.4 (page 37), and by inference much greater than the numbers reported there for Class 1 railroads. However, Aurizon Network's calculation of DOL is not consistent with the benchmark against which it was compared.

The column above our figure of 1.01 is titled ' γ_1 from regression of Ln(Sales) vs Ln(EBIT)', and Appendix D of our previous report explained how we had derived our estimate for Aurizon Network and the Class 1 railroads:⁶⁷

The most commonly used formula to represent operating leverage is:

$$\text{Degree of Operating Leverage} = \frac{\% \Delta \text{EBIT}}{\% \Delta Q}$$

Where, ΔEBIT is the change in Operating Income Before Tax, and ΔQ is the change in the number of units sold. An empirical estimation of this relationship can be obtained through estimating the γ_1 coefficient in a regression of the form:⁶⁸

$$\text{Ln EBIT} = \gamma_0 + \gamma_1 \text{Ln Sales} + \mu$$

Aurizon Network applied the first approach (i.e. it measured DOL only for itself simply as the change in EBIT relative to the change in quantity), which is not what we did for the following reasons, including the potential volatility of year to year estimates, and the fact that 'units sold' was not an easily obtained, or easily understood, measure for the diverse firms in our wider sample (e.g. when different units are sold in diversified operations). Instead we applied the second approach, where the regression method is used, and 'sales' are defined in terms of revenue.⁶⁹ When calculated in the same way (i.e. applying the regression approach), our previous report found an Aurizon Network operating leverage of 1.01, which was significantly lower than the Class 1 railroads (ranging from 1.40 to 2.26). We found that all three measures of Operating Leverage - ' γ_1 from regression of Ln(Sales) vs Ln(EBIT)', the Inverse of EBIT Margin, and Opex / Assets – indicated that Aurizon Network had lower operating leverage than the Class 1 railroads. However, we concluded that Aurizon Network's

⁶⁷ See Incenta (9 December, 2013), p. 81.

⁶⁸ See, for example, Xue Zhang, (15 August, 2012), *The Role of Operating Leverage in Asset Pricing*, Master Thesis in Finance, Tilburg University.

⁶⁹ To smooth out potential outlying observations, we ran a number of overlapping 5 year regressions and took the median value of γ_1 as the estimate of operating leverage.

regulatory framework, by dampening movements in EBIT, was likely to dominate any natural operating leverage effect in any case.

Opex/assets ratio

Aurizon Network compares the opex/assets ratio of Aurizon Network against Australian regulated transmission businesses, but this is not the relevant comparison to make. It is far more relevant to compare the average opex/assets ratio of Aurizon Network against the 70 businesses comprising our sample of international regulated energy businesses, because we have relied upon the estimated asset beta of this group to estimate the asset beta of Aurizon Network. In reviewing the average opex/assets ratio of Aurizon Network for the 2009-2012 period we noticed that unlike the Authority’s measure, Bloomberg’s definition of operating expenditure includes depreciation, and this component needs to be removed to compare the opex/assets ratio measured by Bloomberg. In Table 4.3 below, we show the average opex/assets ratio measured both ways (i.e. with opex including and net of depreciation).

Table 4.3: Average opex/assets ratio (2009-2012)

Company / Industry	N	Opex / Non-current assets	(Opex + Depreciation) / Non-current assets
Aurizon Network	1	7.5%	10.8%
Regulated energy	70	11.1%	14.6%
Class 1 railroads	7	23.9%	27.3%

Source: QCA, Bloomberg. Note: 1) Opex defined as net of depreciation. 2) For Aurizon Network non-current assets proxied by RAB.

We find that whichever way the opex/assets ratio is measured, it is lower for Aurizon Network than for the 70 firm regulated energy group sample that was used to estimate an asset beta, and lower than for Class 1 railroads. We concur with Aurizon Network that the opex/assets measure is likely to overstate the relative operating leverage of US Class 1 railroads due to their larger proportion of variable costs: however the opex/assets measure is used in academic papers as a proxy for degree of operating leverage. In addition, we note that we have also relied on the responsiveness of EBIT to sales and the inverse of the EBIT margin, which is also likely to overstate the relative operating leverage of US Class 1 railroads due to their larger proportion of variable costs. Whilst we accept that these measures of operating leverage have weaknesses, and this is a difficult concept to accurately measure, we consider that on all measures Aurizon Network is shown to be more similar to regulated energy businesses than to US Class 1 railroads. In any case, in our original report we expressed the view that operating leverage is unlikely to be an important determinant of systematic risk for a regulated business like Aurizon Network, because its regulatory framework acts to dampen earnings fluctuations, and decouples the remaining earnings volatility from systematic risk factors.

4.9 Application of the simulated months method to estimate beta

4.9.1 Issues raised by Aurizon Network and SFG

Aurizon Network’s adviser SFG has submitted that Incenta incorrectly applied its simulated month method in estimating asset betas for its samples of comparators with the result that approximately half of the sample of the distributions of simulated month betas were bi-modal, and that this resulted in an

under-estimate of the correct asset beta estimate using that method. Based on the Central Limit Theorem (CLT), Aurizon Network considers that the distributions of SIM-betas obtained using Incenta's method should be normal.

4.9.2 Incenta's response

We acknowledge that our original data contained a bimodality in the distributions of the simulated beta results, which was an error. This bimodality was caused by the accidental inclusion of a set of earlier simulation results with the correct ones. Approximately 999 observations were included from one distribution and 3996 from another. The simulations were so computer intensive that batches of 999 (the original data was used for the first) were estimated. The problem occurred when four earlier batches were included with the correct batch. In order to correct this problem we have completely rewritten our simulation routine to be significantly faster and use less computer resources. The results presented here use the results of this improved simulation and, as explained below, they do not materially differ from the previous results.

We individually examined all of the new distributions for each of the sample firms, and found that while only a small number are technically normally distributed (7 out of 107), almost all follow a unimodal pattern. In a technical appendix (Appendix A) we provide a detailed explanation of why a normal distribution will not automatically be observed. In aggregate, the revised SIM beta estimates are close to those provided in our original report.⁷⁰ As shown in Table 4.4 below, the coal and airport industry SIM asset betas increased marginally, while the toll-road industry SIM asset betas stayed approximately the same. For rail businesses the average SIM asset beta decreased slightly while the median increased slightly.

Importantly, the median SIM asset beta estimate for energy reduced only marginally from 0.42 to 0.41, while the average SIM asset beta stayed approximately the same at 0.41. The average SIM asset beta for the water industry reduced from 0.41 to 0.40, and the median value fell marginally from 0.40 to 0.38. We have therefore revised our original recommendation of a 0.42 asset beta estimate for Aurizon Network down to an asset beta estimate of 0.41.⁷¹

⁷⁰ See Appendix A for further detailed comments on the econometric aspects of the simulation analysis, including a selection of the distributions matching the ones highlighted by Aurizon Network.

⁷¹ We also note that combining the regulated energy and regulated water industries obtains SIM-asset beta estimates of 0.41 (for both mean and median).

Table 4.4: New SIM asset beta estimates compared with previous SIM asset beta estimates

Industry	Number of firms	SIM asset beta - previous		SIM asset beta - revised	
		Mean	Median	Mean	Median
Coal	10	1.26	1.35	1.23	1.32
Rail	7	0.93	0.89	0.91	0.91
Airport	6	0.65	0.63	0.66	0.65
Tollroad	7	0.49	0.49	0.49	0.49
Energy	70	0.41	0.42	0.41	0.41
Water	7	0.41	0.40	0.40	0.38

Source: Bloomberg and Incenta analysis

We note that our revised SIM asset beta estimates are significantly lower than the range of 0.51 (median) to 0.55 (average) reported by Aurizon Network.⁷² We cannot explain this differential, but in the next section below we show that this cannot be due to differing tax rate assumptions, or de-levering approaches. We also show that by using standard Bloomberg raw betas, rather than those that Incenta has itself estimated based on share price movements and dividend payments, an asset beta of 0.41 or slightly lower is indicated based on the evidence for regulated energy and water businesses.

In addition, we note that less than 6 months prior to the publication of our original report, Aurizon Network’s adviser, SFG, released a report that estimated the equity beta of 56 regulated international (i.e. US) and 9 regulated Australian energy businesses. SFG concluded that the 60 per cent geared equity beta for regulated energy was on average 0.82.⁷³ Applying the Conine formula, 55 per cent gearing and a debt beta assumption of 0.12, we find that SFG’s results implied an asset beta of 0.43. Hence, Aurizon Network’s adviser’s estimate of the asset beta for Australian and US regulated energy businesses was only 0.02 higher than our estimate of 0.41, and is 0.02 lower than the 0.45 asset beta that was subsequently applied to Aurizon Network in the QCA’s draft report.

4.10 De-levering the equity beta

4.10.1 Issues raised by Aurizon Network

Aurizon Network’s submission considers that Incenta has erred in its de-levering of the comparator equity beta estimates. For the energy and toll-road sub-samples Aurizon Network submits that Incenta de-levered incorrectly and used the wrong tax rates, and as a result the median asset betas rise from 0.49 to 0.54, and from 0.42 to 0.51 respectively. However, it conceded that such differences are unlikely to be caused by tax rate differentials, and hence the de-leveraging formula must be incorrectly applied.

⁷² Aurizon Network (19 December, 2014), p. 199.

⁷³ SFG, (24 June, 2013), *Regression-based estimates of risk parameters for the benchmark firm*, p.13. The 60 per cent geared beta was 0.89 and 0.58 for the respective groups of firms, but SFG gave double weighting to the 9 Australian firms in the sample.

4.10.2 Incenta’s response

Our original report noted that we used effective tax rates on a firm by firm basis to de-lever the equity betas of sample firms, and applied them using the Conine formula assuming a debt beta of 0.12. It is appropriate to use the long term marginal effective tax rate that will be incurred by each business because the objective of de-levering is to strip out all effects except for the underlying systematic component. We accept that the statutory tax rate is often applied as an estimate of the long term marginal effective tax rate, even if the current effective tax rate is lower than the current statutory rate. However, we have estimated long term effective tax rates for each firm (based on 10 years of data) because we believe this is likely to provide a better proxy for the long term marginal tax rate. We agree with Aurizon Network that it is unlikely that the differences between its estimates and our estimates of asset beta are due to the application of different tax rates in the de-levering process.

To demonstrate our de-levering approach, we begin with the Conine de-levering formula:

$$\beta_a = \frac{\beta_e + \beta_d(1 - T)\left(\frac{D}{E}\right)}{\left(1 + (1 - T)\left(\frac{D}{E}\right)\right)}$$

Where, β_e , β_a and β_d are respectively the equity, asset and debt betas, D and E are the values of net (book) debt and market equity, and T is the tax rate. As an example, we show how we applied the deleveraging formula to American Economic Power (AEP), which is part of our 70 regulated energy firms sample. The values of the inputs used are shown below, with β_e being the SIM equity beta of 0.595 estimated using the SIM equity beta estimation method described in our previous report. The SIM asset beta of 0.412 is then calculated as follows:

$$\beta_a = 0.412 = \frac{0.595 + 0.12(1 - 0.33)(0.934)}{\left(1 + (1 - 0.33)(0.934)\right)}$$

For the beta estimation period of 2003 to 2013, the annual average values for net debt, market capitalisation and effective tax rate (all readily verifiable from Bloomberg), are shown in Appendix A.1.1 below.

Table 4.5 below illustrates the sensitivity of asset beta to alternative tax rates, and different beta estimation approaches. We show Incenta’s revised standard Ordinary Least Squares (OLS) asset beta estimates for the toll-road and energy industries as these were the focus of Aurizon Network’s submission.⁷⁴ Using effective tax rates the revised Incenta OLS mean and median asset beta estimates for the energy industry are 0.39 and 0.38, which are 2 to 3 points below the revised (median) estimated SIM asset beta of 0.41. If statutory tax rates are used the mean and median asset betas are 0.40, which is still marginally below the 0.41 estimated SIM asset beta.

⁷⁴ We have revised our OLS estimates because the original report used the first day of each month to estimate the change in share price, while it is standard to use the last day of the month. The differences in asset beta estimates are immaterial.

Table 4.5: Asset betas - Effect of different tax rates and Bloomberg beta estimates

Tax rates	Revised Incenta OLS (effective tax rates)		Revised Incenta OLS (statutory tax rates)	
	Mean	Median	Mean	Median
Industry				
Toll-road	0.50	0.47	0.47	0.48
Energy	0.39	0.38	0.40	0.40

Tax rates	Revised Bloomberg OLS (effective tax rates)		Revised Bloomberg OLS (statutory tax rates)	
	Mean	Median	Mean	Median
Industry				
Toll-road	0.50	0.51	0.51	0.52
Energy	0.38	0.35	0.39	0.36

Source: Bloomberg and Incenta analysis

The second panel of Table 4.4 displays our findings using Bloomberg’s standard (raw) OLS beta estimates, which do not include dividend payments as part of the total monthly return on share ownership. The Bloomberg OLS asset beta estimates are:

- For toll-roads (effective tax rates) – Incenta’s estimate is the *same* (mean of 0.50) or slightly lower (median of 0.47 compared with 0.51 for Bloomberg);
- For toll-roads (statutory tax rates) – Incenta’s estimate is *slightly lower* (mean/median of 0.47/0.48 vs 0.51/0.52 for Bloomberg);
- For energy (effective tax rates) - Incenta’s estimate is *slightly higher* (mean/median of 0.39/0.38 vs 0.38/0.35 for Bloomberg); and
- For energy (statutory tax rates) - Incenta’s estimate is *slightly higher* (mean/median of 0.40/0.40 vs 0.39/0.36 for Bloomberg);

Using statutory tax rates instead of effective tax rates) adds only approximately 0.01 to the beta estimate. In summary, the asset betas for the regulated energy industry based on Incenta’s OLS estimates and Bloomberg raw equity betas are slightly lower than the 0.41 estimated using the SIM beta estimation approach.

We also re-confirmed our gearing estimates for each firm in the samples, which were based on the average of daily market capitalisation (equity value) and quarterly or annual (depending on availability) net debt values that are available from Bloomberg for the up to 10 year period ending June 2013 (depending on data availability). We re-estimated gearing by taking the quarterly (or annual) market capitalisation, and quarterly or annual (depending on availability) net debt values and obtained almost precisely the same gearing and asset beta estimates. Hence, if Aurizon Network applied similar gearing assumptions to ours, the 0.10 (median) to 0.14 (average) higher SIM-asset beta estimates obtained by it would necessarily be due to significantly higher SIM-equity beta estimates.

We have found a relatively close correspondence between the asset beta estimates for international regulated energy and water networks regardless of the method applied:

- 0.39/0.40 (average) and 0.38/0.40 (median) based on Incenta’s own revised OLS estimates (i.e. including dividend payments as part of the monthly shareholder return) for the sample of 70 international businesses (using effective/statutory tax rates);
- 0.38/0.39 (average) and 0.35/0.36 (median) based on Bloomberg’s OLS estimates (i.e. excluding dividend payments from the monthly shareholder return) for the sample of 70 international businesses (using effective/statutory tax rates);
- 0.41 (average) and 0.41 (median) based on applying Incenta’s (revised) SIM-beta method to the sample of 70 international businesses (using effective tax rates);
- 0.43 obtained by Aurizon Network’s adviser (SFG) applying an OLS method to 56 US and 9 Australian regulated energy businesses; and
- a 0.41 (average) and 0.41 (median) asset beta based on applying Incenta’s (revised) SIM-beta method to the combined sample of 70 international regulated energy businesses and 7 international regulated water businesses (using effective tax rates).

Since all of these estimates are in the range of 0.35 to 0.43, we are confident that the asset beta point estimate of 0.41 is an appropriate estimate of the asset beta for Aurizon Network’s regulated assets. Consequently, we are concerned that Aurizon Network’s SIM-asset beta estimates for our 70 firm international regulated energy businesses sample (0.55 (average) and 0.51 (median)) are materially higher, and are likely to be the products of some methodological error. The academic literature on the turn of the month effect has not found such significant influences, and if it had we would have expected to see the SIM-asset beta method applied more widely.

4.11 Industry classification

4.11.1 Issues raised by Aurizon Network

Aurizon Network’s submission states that it uncovered an error in the industry classifications used in the Incenta report:⁷⁵

The Incenta’s report indicated that there are 7 toll-road and 70 energy firms within the sample. However, if the sample composition from Incenta’s data is analysed further (using industry classifications provided in the dataset), a different number of firms within each industry group is identified to those reported.

As a result, Aurizon Network undertook further research and identified that Incenta has:

⁷⁵ Aurizon Network (19 December, 2014), p.198.

- *Misclassified Societa Iniziative Autostradali e Servizi SpA, an Italian toll-road company, as a business in the airport industry; and*
- *CONSOL Energy, a US coal mining business, as a business in the energy sector.*

Aurizon Network’s submission on this matter concluded with a note of concern:

Although these oversights may not have materially affected the final results, it raises some concerns as to how carefully the analysis has been conducted.

4.11.2 Incenta’s response

Aurizon Network is correct in noting the raw data file that was provided to it contained the two misallocations of firms to the incorrect industries. However, this initial misallocation was picked up by us before our original report was concluded, which is transparently observable from *Appendix A: Sample selection and description*, in our original report. Hence, the correct industry classifications were applied in our analysis.⁷⁶

4.12 Other submissions by stakeholders

Like Aurizon Network, SFG and QRC, Vale’s submission appears to assume that Incenta averaged the ‘lower’ and ‘upper-bound’ beta estimates of DBCT and toll-roads to derive an asset beta estimate for Aurizon Network. For example, Vale’s submission stated:⁷⁷

Vale believes the use of toll-road in the range of estimates is likely to result in an upward bias in the asset beta range as their level of risk is significantly higher than Aurizon’s.

Similarly, Anglo-American expressed dissatisfaction with Incenta’s beta analysis and the approach taken by the Authority:⁷⁸

Anglo American reiterates its concerns that Incenta’s approach incorrectly simplified the categorisation of benchmarks... In particular, Anglo American notes that while the QCA has acknowledged which benchmarks set those upper and lower bounds (specifically, toll-roads at 0.49 and DBCT at 0.35), it has not appropriately compared Aurizon Network’s profile.

4.12.1 Incenta’s response

We reiterate that while our analysis was framed by the ‘upper’ and ‘lower’ bound limits, it did not involve simply averaging these ‘upper’ and ‘lower bounds’. Rather, it was instead largely influenced

⁷⁶ Incenta (December, 2013), pp.68-72.

⁷⁷ Vale (12 December, 2014), *Aurizon Network’s 2014 Draft Access Undertaking (UT4) Maximum Allowable Revenue Draft Decision*, p.6.

⁷⁸ AngloAmerican (December, 2014), *Submission to the Queensland Competition Authority – Response to the QCA Draft Decision on Aurizon Network’s Maximum Allowable Revenue*, p. 12.

by the mean and median asset beta estimates for 77 regulated energy and water comparators, which were deemed to have the closest systematic risk characteristics to Aurizon Network.

4.12.2 Conclusion on beta estimation

Having reviewed and responded to the concerns raised by stakeholders in relation to our original report, we consider that no issue raised by submissions causes us to revise the approach we applied in our original report. Aurizon Network, SFG and The Brattle Group have not provided new evidence demonstrating that our first principles assessment of Aurizon Network's systematic risk was incorrect in concluding that its closest comparators are regulated energy and water businesses. We do not consider that it is appropriate (as suggested by SFG and Aurizon Network) to provide weight to rail and other transport industry firms whose systematic risk fundamentals are materially different to those of Aurizon Network, and imply greater systematic risk. The provision of any weight to an inaccurate estimate of Aurizon Network's asset beta would distort the estimate of Aurizon Network's asset beta.

Accordingly, based on our revised SIM-beta estimates for 70 international regulated energy businesses and 7 regulated water businesses, which we consider to be the best comparator groups for Aurizon Network, we recommend that 0.41 is our best point estimate of Aurizon Network's asset beta.

A. Comments responding to technical issues raised in Aurizon Network’s Appendix 10.5.2

In Appendix 10.5.2 of Aurizon Network’s submission, based on the econometrics textbook by Hill, Griffiths and Lim (2011), a case is presented that the distributions of SIM betas obtained using Incenta’s SIM beta estimation method should be normally distributed.

Incenta’s response

The simulation performed in this case is quite different from a simple application of the Central Limit Theorem to the distribution of regression parameter estimates via OLS as can be found in introductory textbooks such as Hill, Griffiths and Lim (2011) (hereafter referred to as HGL). The basic assumption in the elementary textbook approach is that the regressors are fixed – or non-stochastic. To quote from an introductory econometrics text (“assumption 5: The variable x is *fixed* and must take on at least two different values.”). However, Aurizon Network’s submission does not appear to acknowledge appendix 5B of Chapter 5 in HGL in which there is a discussion of asymptotic normality and random regressors.

In the case considered here the regressors are generated by two random processes: first the usual case when estimating beta when one assumes there are random forces that generate the market rate of return and second in the case considered here, when one simulates a random process to generate lengths and starting dates of pseudo-months. In the case of the usual estimate of beta one uses the consistency results instead of the unbiased results. Under these conditions OLS is not BLUE (i.e. the ‘best linear unbiased estimate’) however it is usually consistent which is a weaker result and does not imply that the coefficient estimates will be normally distributed with small samples.

In order to examine this process a bit more closely consider a set of observations on the price of asset i on day t denoted by Y_{it} the value of a portfolio of assets in the market on day t denoted by X_t .⁷⁹ We can then define the rate of return on the asset for a month as the difference in the logs of the value of the asset at the end of the month prior to that month (i.e. the start of the month) and end of the month: $y_{it} - y_{it-m}$ where there are m days in the month and $y_{it} = \log(Y_{it})$. The equivalent rate of return for the market as $x_{it} - x_{it-m}$ and $x_{it} = \log(X_{it})$. Thus we obtain a regression of the form:

$$\mathbf{Py} = \mathbf{Px}\beta + \alpha + \varepsilon$$

Where \mathbf{P} is a N by T matrix made up of N 1 by T row vectors of the form:

⁷⁹ In this example we abstract from the need to subtract the risk-free asset and not include dividend payments to simplify our presentation. Inclusion of more detail would not change the result.

$$\mathbf{P} = \begin{bmatrix} \mathbf{p}_1 \\ \mathbf{p}_2 \\ \vdots \\ \mathbf{p}_N \end{bmatrix}$$

These vectors are defined such that the return for asset i in month 1 would be provided by $y_{it} - y_{it-m} = \mathbf{p}_1 \mathbf{y}_i$. Thus the interval for each month is determined by the calendar for that month. Where these vectors are of the form:

$$\begin{aligned} \mathbf{p}_1 &= [-1 \quad \dots \quad 1 \quad 0 \quad \dots \quad \dots \quad \dots \quad 0] \\ \mathbf{p}_2 &= [0 \quad \dots \quad -1 \quad \dots \quad 1 \quad 0 \quad \dots \quad 0] \\ &\quad \vdots \\ \mathbf{p}_N &= [0 \quad \dots \quad \dots \quad \dots \quad \dots \quad -1 \quad \dots \quad 1] \end{aligned}$$

This implies that the matrix has the form:

$$\mathbf{P} = \begin{bmatrix} -1 & \dots & 1 & 0 & \dots & \dots & \dots & 0 \\ 0 & \dots & -1 & \dots & 1 & 0 & \dots & 0 \\ & & & \vdots & & & & \\ 0 & \dots & \dots & \dots & \dots & -1 & \dots & 1 \end{bmatrix}$$

The simulations involve the construction of a series of matrices of the form of \mathbf{P} that conform to the process by which the number of days in a month are determined. Thus the construction of these simulated OLS estimates are based on the same daily data that have been weighted according to a stochastic process that determines the beginning and end of each month. This implies that we have a series of regressions of the form:

$$\mathbf{P}_j \mathbf{y} = \mathbf{P}_j \mathbf{x} \beta_j + \alpha_j + \boldsymbol{\varepsilon}_j$$

Where j indicates the simulation performed.

The OLS estimate of the slope parameter $\hat{\lambda}$ from a simple regression of the form $\mathbf{w} = \mathbf{z}\lambda + \boldsymbol{\theta} + \boldsymbol{\varepsilon}$ can be defined as the same as the slope parameter when we fit a model with no intercept to the data when deviated from their means: $(\mathbf{w} - \mathbf{1}\bar{w}) = (\mathbf{z} - \mathbf{1}\bar{z})\lambda + \boldsymbol{\varepsilon}$ or $(\mathbf{I} - \frac{1}{N}\mathbf{u}'\mathbf{u})\mathbf{w} = (\mathbf{I} - \frac{1}{N}\mathbf{u}'\mathbf{u})\mathbf{z}\lambda + \boldsymbol{\varepsilon}$

$$\hat{\lambda} = \frac{\sum_{i=1}^N (z_i - \bar{z})(w_i - \bar{w})}{\sum_{i=1}^N (z_i - \bar{z})(z_i - \bar{z})}, \text{ or } \hat{\lambda} = (\mathbf{z}'(\mathbf{I} - \frac{1}{N}\mathbf{u}'\mathbf{u})\mathbf{z})^{-1} (\mathbf{z}'(\mathbf{I} - \frac{1}{N}\mathbf{u}'\mathbf{u})\mathbf{w})$$

Where we have constructed the matrix equivalent to the sigma notation form using the N dimension column vector of 1s defined as $\mathbf{1}$ and the N dimension identity matrix \mathbf{I} .⁸⁰

If we substitute for the regressors in the rate of change regression case we get $\mathbf{w} = \mathbf{P}\mathbf{y}$, $\mathbf{z} = \mathbf{P}\mathbf{x}$ for the model $(\mathbf{I} - \frac{1}{N}\mathbf{u}')\mathbf{P}\mathbf{y} = (\mathbf{I} - \frac{1}{N}\mathbf{u}')\mathbf{P}\mathbf{x}\beta + \varepsilon$ thus in the case of the regression on the rates of change we have:

$$\hat{\beta} = (\mathbf{x}'\mathbf{P}'(\mathbf{I} - \frac{1}{N}\mathbf{u}')\mathbf{P}\mathbf{x})^{-1} (\mathbf{x}'\mathbf{P}'(\mathbf{I} - \frac{1}{N}\mathbf{u}')\mathbf{P}\mathbf{y})$$

Or equivalently by using $(\mathbf{P}\mathbf{y} - \mathbf{1}\overline{\mathbf{P}\mathbf{y}}) = (\mathbf{P}\mathbf{x} - \mathbf{1}\overline{\mathbf{P}\mathbf{x}})\beta + \varepsilon$ we could write this as:

$$\hat{\beta} = \beta + \mathbf{Q}(\mathbf{P}, \mathbf{x})' \varepsilon, \text{ where } \mathbf{Q}(\mathbf{P}, \mathbf{x}) = (\mathbf{x}'\mathbf{P}'(\mathbf{I} - \frac{1}{N}\mathbf{u}')\mathbf{P}\mathbf{x})^{-1} \mathbf{x}'\mathbf{P}'(\mathbf{I} - \frac{1}{N}\mathbf{u}')$$

Under the assumptions of a stable stochastic regressor that is not correlated with the error term the usual result of unbiasedness is that $E(\hat{\beta}) \neq \beta$ is not available however we use the property that the probability limit of the estimate is equal to the parameter. In this case we have:

$$\begin{aligned} \text{Plim}_{N \rightarrow \infty} \hat{\beta} &= \beta + \left(N \text{Plim}_{N \rightarrow \infty} \frac{1}{N} (\mathbf{x}'\mathbf{P}'\mathbf{P}\mathbf{x}) - \text{Plim}_{N \rightarrow \infty} \frac{1}{N} (\mathbf{1}'\mathbf{P}\mathbf{x})^2 \right)^{-1} \left(N \text{Plim}_{N \rightarrow \infty} \frac{1}{N} (\mathbf{x}'\mathbf{P}'\mathbf{P}\mathbf{x}) - \text{Plim}_{N \rightarrow \infty} \frac{1}{N} (\mathbf{1}'\mathbf{P}\mathbf{x}) \text{Plim}_{N \rightarrow \infty} \frac{1}{N} (\mathbf{1}'\varepsilon) \right) \\ \text{Plim}_{N \rightarrow \infty} \hat{\beta} &= \beta + \lim_{N \rightarrow \infty} \text{Var}(\mathbf{P}\mathbf{x})^{-1} \lim_{N \rightarrow \infty} \text{Cov}(\mathbf{P}\mathbf{x}, \varepsilon) \end{aligned}$$

Thus since we assume that $\lim_{N \rightarrow \infty} \text{Cov}(\mathbf{P}\mathbf{x}, \varepsilon) = 0$, $\text{Plim}_{N \rightarrow \infty} \hat{\beta} = \beta$: the estimates will be consistent.

Note that the simulations are based on a fixed defined stochastic process based on the distribution of days of the month, thus if we construct S simulations $\text{Plim}_{S \rightarrow \infty} \frac{1}{S} (\mathbf{x}'\mathbf{P}'\mathbf{P}_j\mathbf{x}) = C_1$ the average sum of the squares of the simulated rates of return are constant along with the average of the rates of return

$$\text{Plim}_{S \rightarrow \infty} \frac{1}{S} (\mathbf{1}'\mathbf{P}_j\mathbf{x}) = C_2$$

This implies that when \mathbf{P} is fixed in the usual case when we use monthly rates of return, that the properties of the estimates of β will conform to the conditions under which the distribution will follow the distribution of the error term. However, when the \mathbf{P} matrix is also stochastic the distributional properties of the estimated β will be significantly more complex. The examples of the distributions of the resulting OLS parameters under various stochastic assumptions are primarily concerned with examination of cases where the distribution of the error is non-normal.⁸¹ The other factor that makes the simulation necessary is that each asset's series will be influenced by daily events that will be picked up by different definitions of the matrix \mathbf{P} . If an asset has a very steady level then one would

⁸⁰ Using the idempotent property of the $(\mathbf{I} - \frac{1}{N}\mathbf{u}')$ matrix.

⁸¹ For example the simulation reported on in Hill, Griffiths and Lim (2011) in Table 5B.1.

expect that the variation in the estimate for beta would be fairly robust to different definitions of **P**. However, when the distribution indicates wide dispersion one would assume that the variation would be substantial. For this reason it is not surprising that the distribution of the simulated values of beta do not become normal without a high number of simulations. However, given the nature of the stochastic construction of **P** one can assume that these estimates are consistent estimates.

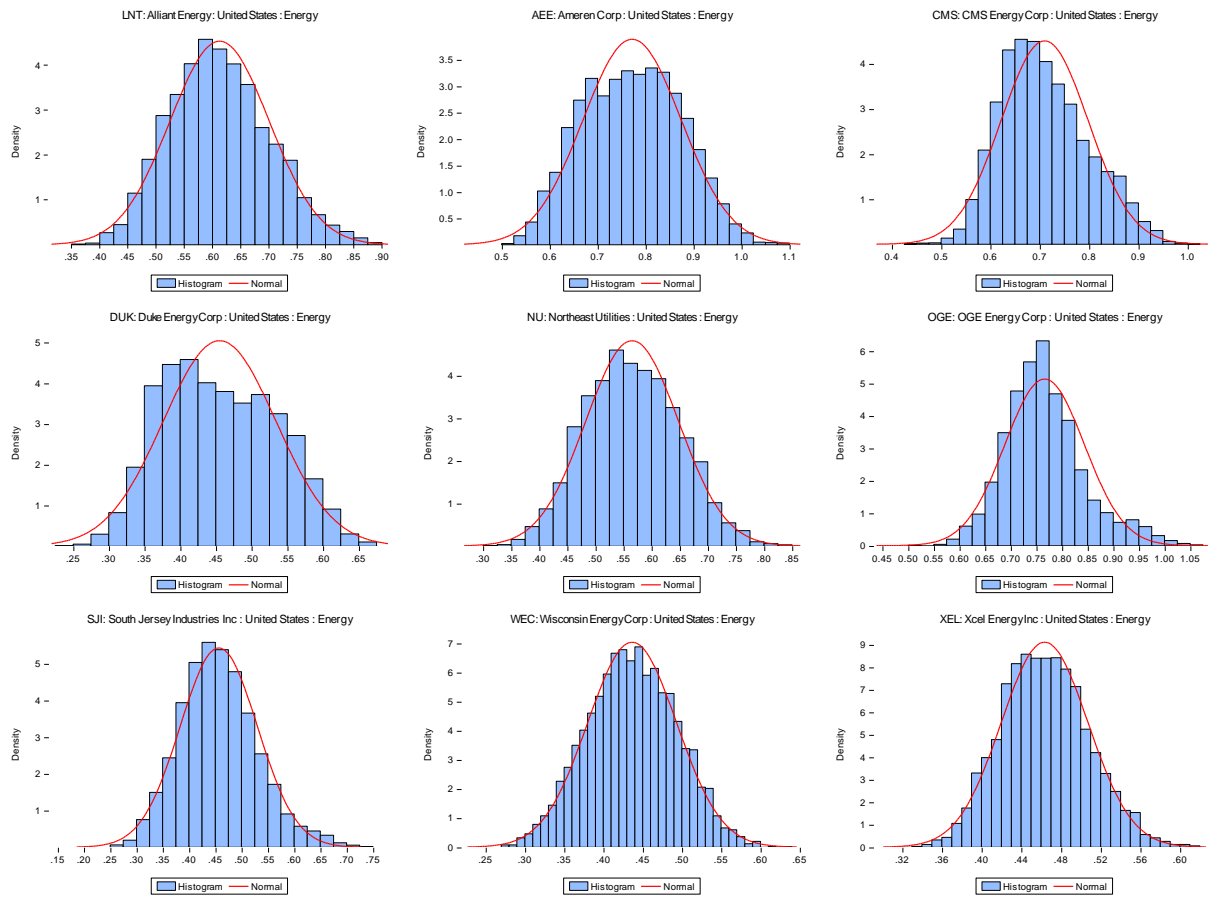
Problems in the simulations

Some problems in the simulations resulted in a mix of simulated results in the files originally used which appeared as a bimodality in the plots of the OLS parameter estimates highlighted in Appendix 10.5.3 of Aurizon Network's submission. As noted in the main body of this report, the bimodality was caused by the accidental inclusion of a set of earlier simulation results with the correct ones. Observation of these plots shows that approximately 999 observations appear from one distribution and 3996 from another. The simulations were so computer intensive that batches of 999 (the original data was used for the first) were estimated, and the problem occurred when four earlier batches were included with the correct batch. To correct this problem we completely rewrote our simulation routine to be significantly faster and use less computer resources. The results presented in the main body of the report and below use the results of this improved simulation.

Plots of selected asset Betas

The plots below have been selected to correspond to the plots of the assets that appear in Aurizon Network's Appendix 10.5.3. Note that most of these simulated distributions while unimodal are not very close to normal. In a related analysis we found that we were unable to reject the hypothesis of normality at the 5 per cent level with a Jarque-Bera test in only 7 of the 107 simulations. In most cases both the skewness and kurtosis indicated a non-normal distribution although they appear unimodal.

Table A.1: Selected histograms of raw OLS Beta estimates with implied normal.



Source: Bloomberg and Incenta analysis

A.1.1 Inputs for American Electric Power

In the text we have demonstrated how we de-levered the estimated SIM equity beta of 0.595 to a SIM asset beta of 0.412 based on a number of inputs for net debt, market capitalisation (equity value) and effective tax rate. In Table A.2 we show that these inputs are supported by the following annual averages drawn from Bloomberg data between 2003 and 2013. As we estimated betas for 10 years to June 2013, these annual averages are slightly different to those used in the analysis to produce a SIM asset beta estimate of 0.412.

Table A.2: American Electric Power – inputs to Conine asset beta formula

Year ending:	Net Debt (USD mill)	Market Capitalisation (USD mill)	Net Debt/Mkt Capitalisation	Effective Tax rate (%)
31-Dec-03	13,321	12,052	1.105	39.5
31-Dec-04	11,781	13,589	0.867	33.5
31-Dec-05	11,708	14,602	0.802	29.3
31-Dec-06	12,990	16,843	0.771	32.7
31-Dec-07	15,111	18,624	0.811	31.0
31-Dec-08	17,221	13,430	1.282	31.9
31-Dec-09	16,771	16,618	1.009	29.6
31-Dec-10	17,447	17,280	1.010	34.6
31-Dec-11	17,651	19,949	0.885	34.2
31-Dec-12	18,135	20,710	0.876	32.4
31-Dec-13	18,663	22,776	0.819	31.5
Average			0.931	32.7

Source: Bloomberg