APPENDIX D

SFG - Issues relating to Draft Decision
(DRP and Equity Raising Costs)
16 December 2011

Issues relating to Draft Decision

Report for Powerlink

16 December 2011

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1. Executive summary

Background and context

1. SFG Consulting (**SFG**) has been engaged by Powerlink to advise on a number of issues relating to the recent Draft Decision published by the Australian Energy Regulator (**AER**). Specifically, we have been asked to address the following issues:

    a) equity raising costs – comment on the AER's method for calculating benchmark equity raising costs. Specifically, any consequential impacts upon the AER's approach in light of the Australian Competition Tribunal's recent decisions associated with a revised dividend imputation estimate of 0.25; and

    b) debt risk premium – comment on the AER's method for calculating the debt risk premium, based upon the average of observed bond yields. In particular, in the context of current financial market conditions:

        i) the reasonableness of establishing an estimate on the basis of the 9 bonds identified in its Draft Decision;

        ii) the appropriateness of the identified bonds to establish an estimate for Powerlink;

        iii) movement away from reliance, at least in part, on Bloomberg's BBB rated fair value curves (including extrapolated curves).

Summary of conclusions

2. Our conclusions in relation to equity raising costs are:

    a) We agree with the AER that the participation rate for dividend reinvestment plans should be set to 30%;

    b) We agree with Powerlink, that dividend policy should be modelled on the basis of dividend yield rather than the minimum payout rate required to distribute imputation tax credits;

    c) We have identified an error in the AER's calculation of equity raising costs – the calculation should not include negative external equity raising costs in any years;

    d) An appropriate estimate of equity raising costs, consistent with the conclusions set out above, and otherwise adopting the values set out in the AER's Post Tax revenue Model, is $17.28 million over the five-year regulatory control period.

3. Our conclusions in relation to debt risk premium are:

    a) The Bloomberg fair value curve contains relevant information and some weight should be given to it;

    b) The yields of a sample of relevant bonds are also relevant information and some weight should be given to them;

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c) In past determinations, individual bonds have been given weight by using them to test the reasonableness of fair value curves published by data service providers. In more recent determinations, the AER has taken a weighted average of the Bloomberg fair value curve and an individual (APT) corporate bond. In the current case, the AER proposes to reject the Bloomberg fair value curve and place 100% weight on the average yield of a sample of bonds it has selected. That is, the AER has proposed to place less weight on the published fair value curve over time and the AER's estimate has moved further away from the published fair value curve over time. In essence, the AER seeks to place more weight on the sample of bonds it has selected and to use them in a different way to what Bloomberg believes to be appropriate. In our view, this requires some consideration and some justification as to why the AER's use of and weight given to its sample of bonds should be preferred to Bloomberg's use of those bonds;

d) The justification for the use of and weight given to the sample of bonds selected by the AER would depend on:

   i) The size of the sample of relevant bonds;

   ii) Whether the sample of bonds is complete, or has been filtered in some way;

   iii) The representativeness of the sample of relevant bonds (in particular, the term to maturity and credit rating); and

   iv) The characteristics of the relevant bonds that are commonly used when assessing the reliability of yield estimates (e.g., size of issue, liquidity, and consensus between yield estimates from different data sources).

e) In our view, there Draft Decision contains insufficient information to determine whether the AER's use of the sample of bonds it has selected, vis-à-vis the Bloomberg fair value curve, is reasonable.

4. We also note that in the case at hand, the PWC Debt Risk Premium Report states that the Bloomberg BBB fair value curve currently estimates a 5-year DRP of 3.39% and a 7-year DRP of 4.12%. Both of these are above the AER's estimate of the 10-year DRP of 3.19% The PWC Report (pp. 23-24) also sets out some of the relevant literature and a number of reasons why the 10-year BBB DRP is not expected to be below the BBB DRP at shorter maturities. Even if a horizontal extrapolation is applied to the Bloomberg fair value curve, the resulting estimate of DRP is still above the AER estimate.

5. This requires an assessment of the reliability of the Bloomberg curve out to five or seven years relative to that of the average yield from the sample of bonds compiled by the AER. In performing this assessment, the fact that the AER has compiled a relatively small sample of bonds, has excluded some types of bonds, and has not assessed the characteristics of those bonds that are relevant to assessing the reliability of the estimated yields would all be relevant considerations.

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2. Equity raising costs

Overview and context

6. Powerlink and the AER agree that:

   a) Reasonable equity issuance costs should be recovered through the regulatory process;

   b) The recoverable costs only relate to new equity that would be issued in relation to the financing of new capital expenditure;

   c) New equity would only be issued to the extent that retained cash flow was insufficient to finance the equity component of new capital expenditure;

   d) The first form of equity issuance would be a dividend reinvestment plan. The equity issuance costs associated with a dividend reinvestment plan would amount to 1% of the equity capital raised; and

   e) Any further equity issuance required would be in the form of a seasoned equity offering, the costs of which would amount to 3% of the equity capital raised.

7. There are two key differences between the parties:

   a) Powerlink has submitted that 18% of the dividends that are paid out by the benchmark firm can be assumed to flow back under a dividend reinvestment plan. The AER has stated that this proportion should be 30%; and

   b) Powerlink has modelled the dividend policy of the benchmark firm as a stable dividend yield of 8.4%, whereas the AER has modelled dividend policy as the minimum amount required to distribute all dividend imputation tax credits created during the particular year.

Dividend reinvestment plan participation rate

8. Powerlink has submitted that the dividend reinvestment plan participation rate should be set at 18%. That is, 18% of the dividends that are paid out by the benchmark firm can be assumed to flow back under a dividend reinvestment plan. This figure is based on a report from PWC (the **PWC Equity Raising Costs Report**). In that report, PWC compile dividend information from a sample of "comparable" firms. They then show that:

   a) Since 2000, the ratio of total DRP collections to total dividends paid is approximately 18%; and that

   b) Since 2007, the ratio of total DRP collections to total dividends paid *by firms with a DRP in place* is approximately 32%.

9. In particular, the PWC Equity Raising Costs Report concludes that:

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> The results in Table 5.2 below show that based on the full dividend paying history of these firms since 2000, the DRP amount received has averaged at 17.7 percent of the dividends paid, while for actual DRPs that have been instituted by these companies since 2007, the DRP proportion has been 32.7 percent. Since there are gaps in DRP programs, this suggests that assuming an average 32.7 percent return of dividends on a continuing basis will over-estimate the DRP component of long term funding.[1]

10. In its Draft Decision, the AER concludes that the relevant comparator set is those firms with a DRP in place. Some firms will have no need to raise equity capital for a period, and those firms may not have a DRP in place. The AER concludes that a benchmark firm, with a need to raise equity capital, would have a DRP in place, so that the relevant question is the take-up rate of a DRP where one is in place:

> If retained earnings are insufficient, the benchmark firm will then offer a dividend reinvestment plan (the second level of the hierarchy). Hence, the relevant comparator set comprises those firms who have sought to obtain equity via a dividend reinvestment plan.[2]

11. The Draft Decision then notes that the AER has previously estimated the take-up rate of DRP's where one is in place and has arrived at an estimate of 30%. The AER also notes that PWC report a similar figure in their report:

> PWC also reported the average take up rate using the appropriate comparator set—that is, excluding dividends where no dividend reinvestment plan was offered. PwC calculated average of 32.7 per cent approximately aligns with the AER's cap of 30 per cent. In such circumstances, the AER considers that a dividend reinvestment plan cap of 30 per cent is a robust estimate for a benchmark efficient energy business and adopts this figure.[3]

12. In our view, it is reasonable for the AER to conclude that a benchmark firm, with a need to raise equity capital, would have a DRP in place, so that the relevant question is the take-up rate of a DRP *where one is in place*. The empirical evidence suggests that where a DRP is in place, the participation rate is approximately 30% on average. Consequently, we adopt a DRP participation rate of 30% in the remainder of this report.

Dividend policy

13. Powerlink has submitted that the dividend policy of the benchmark firm should be modelled as maintaining a stable dividend yield of 8.4%, consistent with the dividend yields of comparable firms outside the GFC period.

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[1] PWC Equity Raising Costs Report, p. 27.
[2] Draft Decision, p. 159.
[3] Draft Decision, p. 159.

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> From Figure 5.1, it is apparent that, apart from the period of the global financial crisis, contrary to the assertion of the AER, market evidence shows that the dividend yield is a relatively stable parameter. Hence, it is a parameter that is well suited to determining the amount of dividends that would be paid by a benchmark regulated infrastructure business.
>
> In summary, we consider that a dividend yield for infrastructure businesses of 8.4 percent should be applied as the benchmark benchmark to determine Powerlink's equity raising cost requirements.[4]

14. In the Draft Decision,[5] the AER rejected Powerlink's proposal to model the dividend policy of the benchmark firm as maintaining a dividend yield of 8.4%. In the Draft Decision,[6] the AER contends that:

    a) Dividend yields are unstable;

    b) There is a lack of comparable data; and

    c) A payout ratio should be used to be consistent with the assumptions that underlie the value selected for the gamma parameter.

We deal with each of these arguments in turn.

Stability of dividend yields

15. The PWC Equity Raising Costs Report shows that the dividend yields of comparator companies are consistently and materially higher than for the average listed firm. It also shows that dividend yields for both groups of companies have been relatively stable, but for the GFC period when a sharp decline in stock prices and a general maintenance of existing dividends saw dividend yields increase temporarily. This is set out in Figure 5.1 of the PWC Report, which is reproduced below.

Figure 5.1: Dividend yields – ASX 200 vs regulated infrastructure, 2006-2010
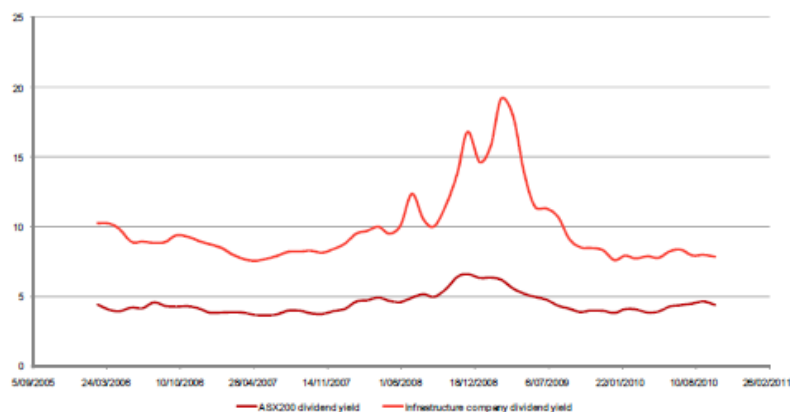
Source: Bloomberg

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[4] PWC Equity Raising Costs Report, p. 26.
[5] Draft Decision, pp. 157-158.
[6] Draft Decision, pp. 157-158.

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16. In our view, the use of the dividend yield method should not be rejected on the basis of an instability argument. Dividend yields for the comparator firms have been relatively stable, but for the GFC period, and Powerlink's submission removes the GFC period from its calculations. The remaining dividend yield series is substantially more stable than the historical time series that the AER uses to estimate other WACC parameters such as MRP, beta, and gearing.

17. Moreover, it is also reasonable to consider that, to be commensurate with the prevailing conditions in the market for funds, the benchmark firm should be considered to provide a dividend yield that is consistent with that provided by comparator firms. In this case, one would require an estimate of the *current* dividend yield provided by the comparator firms and the historical variability in dividend yield would be irrelevant. As it happens, however, the currently observed dividend yield is consistent with the stable (non-GFC) average value.

18. For these reasons, we do not believe that an instability argument can be used to support the rejection of the dividend yield approach.

Lack of comparable data

19. The set of comparator firms that are available for estimating dividend yields is the same set of comparator firms that are available for estimating all other firm-specific WACC parameters (beta, gearing, credit rating). Consequently, the dividend yield method cannot reasonably be rejected on the basis of there being a lack of comparable data.

20. We do not believe that the dividend yield approach should be rejected on the basis of a lack of comparable data.

Consistency with gamma parameter

21. In its 2009 Statement of Revised WACC Parameters (Transmission) (**SRWPT**), the AER determined that gamma should be set to 0.65 based, in part, on an assumed 100% distribution rate. That is, the value of the gamma parameter assumes that 100% of all imputation tax credits created by the firm in a given year are distributed to shareholders in that year. In the current Draft Decision, the AER concludes that dividend policy should be based on an assumed payout ratio rather than an assumed dividend yield and that it should adopt:

> …the assumed dividend payout ratio which would determine the benchmark level of dividends that is consistent with the value of gamma required under the NER regulatory framework.[7]

22. Since the SRWPT, the Australian Competition Tribunal (the **Tribunal**) has found that the AER made a number of errors in arriving at its estimate of gamma. In particular, the AER itself submitted that it had erred in adopting a 100% distribution rate and that value was ultimately replaced by a value of 70%. However, the Rules presently require that for transmission firms the erroneous value of gamma must be maintained until the next review of WACC parameters. It is not clear whether this requires the AER to maintain its erroneous value of the imputation credit distribution rate for the purposes of computing the allowance for equity raising costs. However that question is a moot point in the present case because the tax position of Powerlink is such that it has a relatively small amount of

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[7] Draft Decision, p. 157.

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imputation tax credits relative to its distributable cash flow, in which case it can comfortably distribute all of them. Moreover, both parties' models assume that Powerlink will distribute 100% of the imputation tax credits that it creates.

23. In its Draft Decision, the AER states that its assumed value of gamma is based on 100% of all imputation tax credits being distributed, so the dividend payout ratio must be set to ensure that this occurs. The AER then calculates the amount of dividends that would be required to distribute 100% of the imputation tax credits that are created each year.

24. If the assumed dividend payment must be such that 100% of the imputation tax credits can be distributed, that would represent a *lower bound* on the range of possible dividend payments. A higher dividend would also distribute 100% of the tax credits. That is, the dividend would have to be at least as large as would be required to distribute 100% of the tax credits. In the Draft Decision, however, the AER sets the dividend at the *minimum* level that would be required to distribute 100% of the tax credits.

25. In our view, consistency with the gamma parameter (that the AER must continue to adopt) requires that the dividend would have to be at least as large as would be required to distribution 100% of the tax credits. The Powerlink and AER proposals are both sufficient to distribute 100% of the tax credits, so both are consistent with the assumed value of gamma. Consequently, this consistency issue cannot be used to distinguish between the two proposals.

Reasons for preferring the dividend yield approach

26. In our view, there are a number of reasons for preferring the dividend yield approach proposed by Powerlink to the payout ratio approach proposed by the AER:

    a) The dividend yield approach is based on observed market data from the same comparable firms that are used to estimate other WACC parameters, whereas the payout ratio approach is based on a theoretical assumption that has since been rejected. In particular, in setting the imputation tax credit distribution rate, the AER followed a recommendation from Associate Professor Handley that a theoretical assumption should be used in place of empirical evidence. The Tribunal, and the AER, have since concluded that was an error,[8] but that remains the basis of the AER's proposal in the Draft Decision;

    b) The dividend yield approach produces a point estimate for the dividend that would be paid each year. By contrast, the payout ratio approach only produces a lower bound – any value above that lower bound would still be consistent with the assumed 100% distribution of tax credits; and

    c) It is well-accepted in the finance literature that high-yield firms attract a particular clientele that seek consistent high-yield dividend streams. The PWC Equity Raising Costs Report summarises some of this evidence as follows:

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[8] Application by Energex Limited (Distribution ratio (Gamma)) (No 3) [2010] ACompT 9.

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> …infrastructure businesses attract a specific group of shareholders who value high dividend yields, citing an empirical study by Impson, which noted that the electricity industry 'has a shareholder clientele that invests in it for its generous dividends.' Furthermore, Impson found that the share price of regulated infrastructure businesses responded more negatively to a dividend cut than the share price of non-regulated businesses.[9]

The PWC Report also presents evidence of Australian infrastructure firms maintaining a high dividend yield, while at the same time raising equity capital. All of this evidence is consistent with these firms seeking to maintain a dividend yield that is acceptable to their shareholder base.

d) The dividend yields implied by the Draft Decision range from 3.74% to 4.04% over the five year review period.[10] Such a low dividend yield is materially below the dividend yields that are currently, and ordinarily, available from comparable firms. If the benchmark firm was to reduce dividends to this level for a five-year period, it is likely to result in an exodus of the yield-hungry investors who would ordinarily own such a stock. This would be costly to the firm and, as illustrated below, is likely to be materially more costly than the equity raising costs that would have to be borne if a more standard dividend yield were to be maintained. This implies that it would be unreasonable to set the assumed dividends for the benchmark firm so as to provide a yield that is materially below that of comparable firms.

Conclusions and recommendations

Negative equity raising costs

27. The Draft Decision proposes total equity raising costs of $0.91 million over five years. The PTRM shows that this figure is based on negative external equity raising costs in three of the five years. In those years, there is more than enough cash available (from business operations and the DRP) to fund the equity component of CAPEX, so no external equity is required. The AER's calculations are based on *negative* external equity being raised at a *negative* cost. In reality, of course, it is highly unlikely that relatively small amounts of equity would be retired in these years, and even if they were, this would be costly whereas the current PTRM assumes a *benefit*.

28. In our view, the AER's approach in this regard is unreasonable. A reasonable approach would be to assume that in years that did not require external equity to be raised, none would be raised and there would be no cost or benefit associated with it. If this was done, and the AER's approach was followed in all other respects, the total equity raising cost would be $2.52 million over five years, as set out in Table 1 below. The basis of this calculation is the PTRM that the AER has prepared to be consistent with its Draft Decision. To the extent that any element of the Draft decision is revised, the calculation of equity raising costs would have to be revised accordingly.

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[9] PWC Equity Raising Costs Report, p. 21.
[10] This is computed using information from the **Equity raising cost-capex** sheet in the PTRM. Specifically, we take the dividend in Row 15 and divide by 40% of the opening RAB (reflecting the proportion of equity financing.

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Table 1. Removal of negative external equity raising costs

Year	2012-13	2013-14	2014-15	2015-16	2016-17	Total
External equity raising cost	-0.11	-0.36	0.68	0.07	-1.10	
DRP cost	0.30	0.32	0.37	0.37	0.41	
AER total equity raising cost	0.19	-0.04	1.04	0.45	-0.69	**0.91**
Total equity raising cost without negative external equity raising costs	0.30	0.32	1.04	0.45	0.41	**2.52**

Source: AER Draft Decision PTRM, SFG calculations.

Relationship between dividend yield and equity raising costs

29. The benchmark firm will face a trade-off between setting dividends at a level acceptable to the shareholder clientele and bearing the costs of raising external equity. A higher dividend will require more external equity to be raised and consequently higher costs. To examine this trade-off, we have computed the total equity raising costs over five years for different dividend yields, in all cases assuming a 30% participation rate from a dividend reinvestment plan, and otherwise adopting values from the AER's PTRM. The results are set out in Figure 1 below:

Figure 1. Relationship between dividend yield and equity raising costs

30. If dividends are set to provide a yield of 8.4%, as proposed by Powerlink, total equity raising costs amount to $17.28 million over five years, as set out in Table 2 below. The basis of this calculation is the PTRM that the AER has prepared to be consistent with its Draft Decision. To the extent that any element of the Draft decision is revised, the calculation of equity raising costs would have to be revised accordingly.

31. The equity raising costs in the table below amount to an average of 0.11% of the value of equity each year. The benchmark firm would have to trade off this 0.11% of equity value against the costs that may be caused by an exodus of shareholders in the event of the dividend yield being dropped by more than half for five years. In our view it is reasonable to assume that the cost of a drastic change to

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dividend policy would outweigh the benefit (of reducing the already relatively small equity raising costs) and that a reasonable estimate of equity raising costs is $17.28 million over five years.

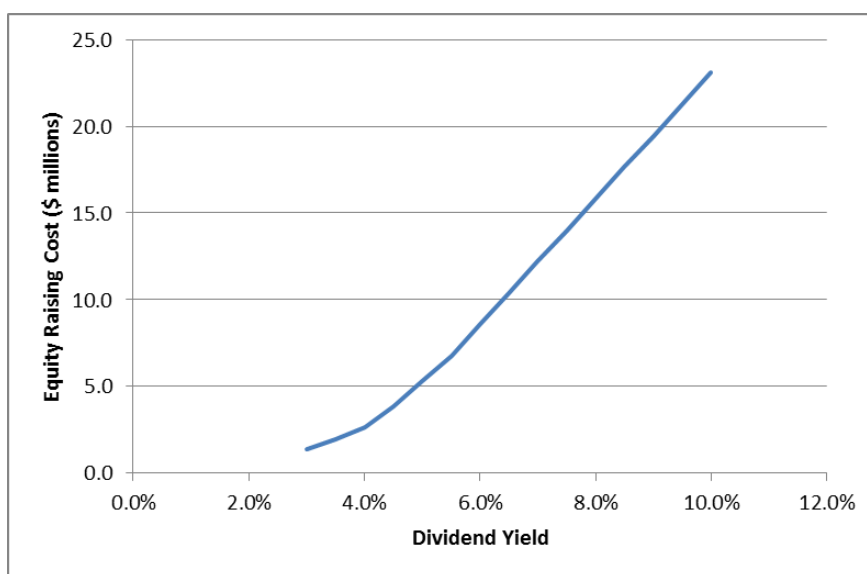**Table 2. Calculation of equity raising costs based on dividend yield**

Year	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Dividend yield	8.40%	8.40%	8.40%	8.40%	8.40%	
Dividend amount	220.95	238.50	253.56	270.35	286.44	
Funds received under DRP	66.29	71.55	76.07	81.10	85.93	
DRP cost	0.66	0.72	0.76	0.81	0.86	
Cash available (including DRP)	147.04	141.45	139.42	139.38	138.75	
CAPEX requirement	227.81	222.02	253.99	243.66	207.46	
External equity required	80.77	80.57	114.57	104.28	68.71	
External equity cost	2.42	2.42	3.44	3.13	2.06	
Total cost	**3.09**	**3.13**	**4.20**	**3.94**	**2.92**	**17.28**

Source: AER Draft Decision PTRM, SFG calculations.

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3. Debt risk premium

Background and context

32. Powerlink has proposed to estimate the debt risk premium (**DRP**) by extrapolating the Bloomberg BBB fair value curve. In particular, the proposed approach is to:

    a) Obtain Bloomberg estimates of the 5 and 7 year debt risk premiums;

    b) Extrapolate each of these estimates out to 10 years, by adding the difference between the Bloomberg AAA 10- and 5-year yields, and the difference between the Bloomberg AAA 10- and 7-year yields, respectively; and

    c) Set the final estimate to be the mid-point of the two extrapolated estimates.

33. Powerlink then proposes to test whether the final estimate is reasonable, primarily by comparing that estimate to the yields of "longer-dated fixed and floating rate bonds (adjusted to fixed rate equivalents) that are available in the BBB and A credit rating bands."[11]

34. In its Draft Decision, the AER has rejected this approach and has instead proposed to use the average yield on nine bonds that it has identified as having:

    a) Credit ratings of BBB, BBB+ or A-; and

    b) Terms to maturity of 7.7 to 11.2 years.

Key issues

Tribunal rulings

35. The Australian Competition Tribunal (the Tribunal) has recently dealt with two cases in relation to debt risk premium. A short summary of each case is set out in the Appendices to this report. Neither case directly considers the approach proposed by the AER in this case, however, they do set out some important principles in relation to the estimation of DRP.

36. In the Jemena Case, the Tribunal held that the reasonableness of a fair value curve could be tested by comparing that curve against the yields of a relevant sample of bonds and that the sample that is used should be as large as possible. In particular, the Tribunal concluded that:

    > We do not agree with Professor Handley's preferred approach to exclude non-standard bonds. Faced with a limited number of relevant bonds, it is appropriate to include bonds with nonstandard features. That said, in including them it is necessary to make appropriate adjustments to remove the impact of the non-standard features.[12]

37. The Tribunal went on to state that:

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[11] PWC Debt Risk Premium Report, p. 35.
[12] Jemena Case, Reasons for Decision, Paragraph 57.

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> The Tribunal is of the view that bonds should only be excluded from the sample on strong grounds (as stated in ActewAGL).[13]

38. In summary, the Tribunal has set out a principal that:

    a) A fair value curve can be tested for reasonableness by comparing it against the yields of a sample of relevant bonds; and

    b) The sample should be as large as possible, including bonds with non-standard features where there is a recognised technique for adjusting for those non-standard features.

Powerlink proposal

39. Powerlink's proposal is to:

    a) Extrapolate the Bloomberg fair value curve (using an approach similar to that previously adopted by the AER); and to

    b) Test that for reasonableness against the estimated yields of a sample of bonds.

AER proposal

40. The AER's proposal is to take the average yield of what it considers to be a relevant sample of corporate bonds.

Conceptual views

41. Our view is that both of the proposed approaches are based on relevant information that should be considered when determining the appropriate DRP. Conceptually, the AER approach is to estimate DRP directly from a sample of relevant bonds. In the prior case law, such a sample of bonds has been used to distinguish between two fair value curves, with the curve that provides the best fit to the sample of relevant bonds being adopted. The AER approach effectively constructs a curve that provides the best possible fit to the observed sample of bonds, and in that sense is a direct estimate.

42. Whereas the bond yields identified by the AER are relevant information and should be considered, this does not imply that only those bond yields should be considered – to the exclusion of other relevant information. In particular, there may be good reasons for the Bloomberg curve deviating from the "best fit" curve. For example, Bloomberg may have access to different or better data, Bloomberg may weight individual bonds differently (e.g., according to issue size or liquidity), Bloomberg may better incorporate information from bonds with different terms to maturity or credit ratings via smoothing parameters, and so on. In our view, the Bloomberg fair value curve does contain some relevant information and it would be unreasonable to give it zero weight.

Implementation

43. In constructing its sample of relevant bonds, the AER has excluded callable bonds:

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[13] Jemena Case, Reasons for Decision, Paragraph 75.

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> The Tribunal has stated that it is appropriate to include bonds with nonstandard features, such as callable bonds, if the yields on these bonds are able to be reliably adjusted to fixed rate equivalents….The AER is aware of a method that applies the Bloomberg YASN function to make the adjustments discussed above. However, the AER has had technical issues with the application of the function, and is undertaking further analysis to address these issues. Accordingly, the AER considers the method for adjusting callable bonds is not, in the current circumstances, sufficiently reliable to include these bonds in the sample.[14]

44. The AER has also excluded subordinated debt, even though that debt has the appropriate credit rating. The Draft Decision states that this is because banks may issue less subordinated debt in the future:

> In the current circumstances, the AER does not consider it appropriate to include subordinated debt in the sample used for the purposes of this draft decision. Including subordinated debt in the sample without an appropriate adjustment to account for this risk [that banks may issue less subordinated debt in future] will reduce the robustness of the sample, and will introduce an upward bias to the DRP estimate.[15]

45. These exclusions result in a relatively small sample of nine bonds with ratings between BBB and A- and terms to maturity between 7.7 and 11.2 years. The implied DRPs range from 2.63% to 4.30%, except for the Coca Cola Amatil bond with a DRP of only 1.59%. We note that the Coca Cola Amatil bond is an outlier in the sense that its estimated yield is not close to the estimated yield of any other bond in the sample. To examine this more closely, we computed the difference between the yield of each bond in the AER's sample and the yield of the next closest bond (i.e., the minimum of the distance between the yield of the bond in question and the yields of the other bonds in the sample). The results are set out in Table 3 which shows that the estimated yield of the Coca Cola Amatil bond is more than 100 basis points from the next closest observation. No other bond in the sample is even half that distance from the next closest bond in the sample.

Table 3. Quantification of outlier bond yield estimates

Bond	Distance to next closest yield (bp)
APT PIPELINES	18
BRISBANE AIRPORT	24
DBCT FINANCE PTY	40
DBCT FINANCE PTY	1
SYDNEY AIRPORT F	1
SYDNEY AIRPORT F	8
STOCKLAND TRUST	18
SPI ELECT & GAS	4
COCA-COLA AMATIL	108

Source: Draft Decision, SFG calculations.

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[14] Draft Decision, p. 217.
[15] Draft Decision, p. 218.

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46. Being an outlier and having an unusually low yield is not, of itself, reason to automatically place zero weight on the Coca Cola Amatil (CCA) bond. However, in such circumstances it would be reasonable for a party proposing to place material weight on that bond (even to the exclusion of the Bloomberg curve that is usually used for this purpose) to justify that such weight was appropriate. The AER has previously determined that the onus remains on any party proposing to place reliance on certain data to establish that this will result in a more reliable outcome.[16] In the case at hand, the CCA bond has only recently been issued, was for a very small amount of funds, and is closely-held and illiquid. These factors all suggest that relatively less reliance should be placed on the CCA bond. In light of this, it is our view that it would be particularly unreasonable to propose that material weight should be placed on the CCA bond, to recognise that there are a number of reasons why one would reasonably consider that less weight should be placed on that bond, but then leave it to others to make that case.

47. In selecting the sample of bonds, there is a trade-off between having a large enough sample to obtain reliable results that are not unduly influenced by a small number of outliers, and having bonds that are truly representative. If the CCA bond is omitted, the resulting sample consists of eight bonds. The Tribunal has previously held that it was unreasonable to rely on a sample of five bonds since there was not sufficient information in such a small sample. This implies that it would not be considered to be reasonable to rely on a sample of eight (or nine) bonds to the complete exclusion of the Bloomberg fair value curve, which has been the standard estimate of DRP.

48. The size of the sample of bonds compiled by the AER has been reduced by making a number of exclusions:

    a) It appears that callable bonds have been excluded from the sample because the AER has not yet developed the capability of making the necessary adjustments; and

    b) Subordinated bonds have been excluded from the sample on the basis that the supply of bank-provided subordinated debt may reduce in the future.

49. Neither of these seem to be compelling reasons, especially when considered against the small sample that results from their exclusion.

Conclusions and recommendations

50. Our conclusions in relation to the estimation of DRP are:

    a) The Bloomberg fair value curve contains relevant information and some weight should be given to it;

    b) The yields of a sample of relevant bonds are also relevant information and some weight should be given to them;

    c) In past determinations, individual bonds have been given weight by using them to test the reasonableness of fair value curves published by data service providers. In more recent determinations, the AER has taken a weighted average of the Bloomberg fair value curve and an individual (APT) corporate bond. In the current case, the AER proposes to reject the Bloomberg fair value curve and place 100% weight on the average yield of a sample of bonds it has selected. That is, the AER has proposed to place less weight on the published fair value curve over time and the AER's estimate has moved further away from the published

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[16] Envestra SA Gas Distribution Final Decision, p.48.

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fair value curve over time. In essence, the AER seeks to place more weight on the sample of bonds it has selected and to use them in a different way to what Bloomberg believes to be appropriate. In our view, this requires some consideration and some justification as to why the AER's use of and weight given to its sample of bonds should be preferred to Bloomberg's use of those bonds;

d) The justification for the use of and weight given to the sample of bonds selected by the AER would depend on:

   i) The size of the sample of relevant bonds. Other things equal, the larger the sample of relevant bonds, the more weight would be applied to them. The Tribunal has previously held that reliance on a sample of five bonds was unreasonable, even when used only to differentiate between fair value curves;

   ii) Whether the sample of bonds is complete, or has been filtered in some way. Other things equal, the more complete the sample of bonds (so that it is a population, rather than a sample), the more weight would be applied to it;

   iii) The representativeness of the sample of relevant bonds (in particular, the term to maturity and credit rating). Other things equal, a sample of bonds that matches the maturity and credit rating of the benchmark firm would receive more weight.; and

   iv) The characteristics of the relevant bonds that are commonly used when assessing the reliability of yield estimates (e.g., size of issue, liquidity, and consensus between yield estimates from different data sources). Other things equal, more weight would be applied to bonds that are part of a large issue, that trade frequently in the secondary market, and for which different data services report the same (or very similar) yield estimates;

e) The Draft Decision does not contain the information set out above, which would reasonably be used to assess the weight that would be applied to the bonds that have been selected by the AER.

51. We also note that in the case at hand, the PWC Debt Risk Premium Report states that the Bloomberg BBB fair value curve currently estimates a 5-year DRP of 3.39% and a 7-year DRP of 4.12%. Both of these are above the AER's estimate of the 10-year DRP of 3.19% The PWC Report (pp. 23-24) also sets out some of the relevant literature and a number of reasons why the 10-year BBB DRP is not expected to be below the BBB DRP at shorter maturities. Even if a horizontal extrapolation is applied to the Bloomberg fair value curve, the resulting estimate of DRP is still materially above the AER estimate.

52. This requires an assessment of the reliability of the Bloomberg curve out to five or seven years relative to that of the average yield from the sample of bonds compiled by the AER. In performing this assessment, the fact that the AER has compiled a relatively small sample of bonds, has excluded some types of bonds, and has not assessed the characteristics of those bonds that are relevant to assessing the reliability of the estimated yields would all be relevant considerations.

53. The Bloomberg fair value curve is an accepted market-based estimate and it has been standard practice to apply at least some weight to it when estimating DRP in regulatory determinations. In our view, it is not reasonable to place 100% weight on the AER's sample of bonds and no weight at all on the Bloomberg curve because:

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a) The sample of bonds is small;

b) The AER's reasons for including some bonds in the sample are not valid; and

c) The Draft Decision contains insufficient information to determine whether the AER's use of the sample of bonds it has selected, vis-à-vis the Bloomberg fair value curve, is reasonable.

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Appendix 1: Summary of ActewAGL Case

Background and context

54. In this case, the parties agreed that a BBB+ credit rating and a 10-year term to maturity was appropriate. The issue to be addressed by the Tribunal was the question of how to best estimate the DRP for 10-year BBB+ corporate debt.

55. Two commercial data services provided estimates of DRPs for corporate debt – CBA Spectrum and Bloomberg.[17] The estimates of DRP were 3.35% from CBA Spectrum and 4.41% from Bloomberg. The reason for the differences in the estimates is that the two services employ somewhat different methodologies and have access to somewhat different data.

56. ActewAGL had proposed to use an average of the CBA Spectrum and Bloomberg estimates, being 3.88%, on the basis that both are well-respected commercial data service providers. This proposal was consistent with the established regulatory precedent at the time. The AER rejected this proposal and instead proposed to use only the (lower) CBA Spectrum estimate.

Issues and Tribunal findings

57. The AER justified its sole reliance on the CBA Spectrum estimate on the basis that that estimate provided the best fit to the available data. In this case, the available data consisted of five bonds selected by the AER, all of which had maturities substantially below 10 years. The relevant fair value curves, and the five bonds selected by the AER, were set out in a figure in the AER's Final determination and that figure also appears in the Tribunal's Reasons and is reproduced below.
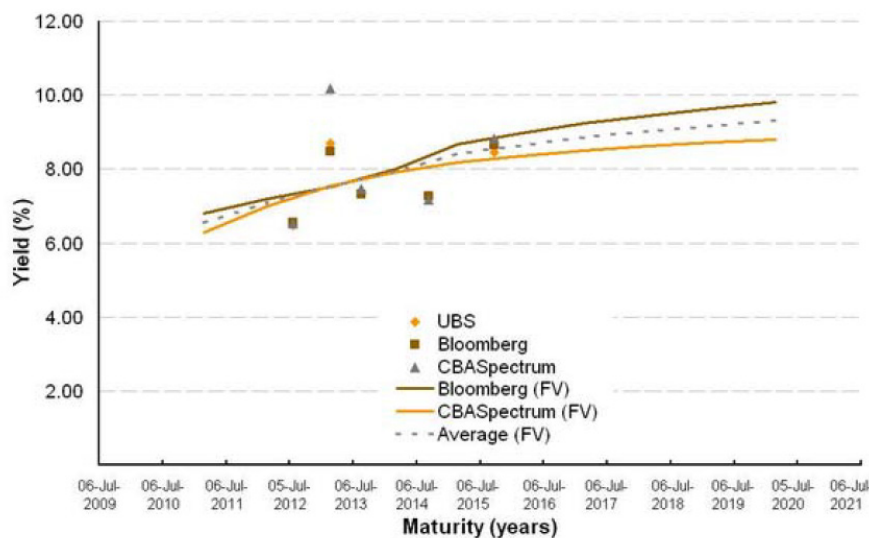
58. The Tribunal held that the AER's sole reliance on the CBA Spectrum estimate, and its reasons for doing so, were unreasonable. In particular, the Tribunal held that the approach on which the AER sought to rely was unreasonable and could not be justified:

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[17] The Bloomberg estimate was published only out to maturities of 8 years, and consequently required extrapolation to 10 years. However, the form of the extrapolation was not in dispute.

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> ActewAGL says that the bonds selected by the AER do not provide a basis for comparison with the fair value curves because the number of bonds is too small and their maturities are too short to be sufficiently representative of the yield on 10-year bonds.
>
> The Tribunal accepts this submission. In the Tribunal's view, it is not reasonable to decide which of three non-linear curves best fits a set of data that consists of only five points, especially when those points cover little more than half of the range of the independent variable, namely the term to maturity. The AER is seeking to select a curve on the basis of how close the observed yields lie to the curves, closeness being measured by the weighted sum of squared differences.
>
> There is not sufficient information to conclude that because the shape and position of a curve up to six years provides a better fit, the same curve will provide a better estimate for greater terms to maturity. Moreover, from inspection of the curves (see above, Figure 5.4 of the AER's final decision) it is evident that data for bonds with terms to maturity of less than 3.5 years could not possibly be used to differentiate between fair value curves estimating the yield on bonds with a term to maturity of even five years or more, as the curves only diverge after 3.5 years. Data for bonds with terms to maturity of 3.5 years or less are effectively irrelevant.[18]

59. The next issue to be considered was whether the population of bonds in the analysis above could be increased – beyond the five that had been selected by the AER. As part of the review process, ActewAGL had proposed a number of methods for doing this, all of which had been rejected by the AER.

60. The first means of increasing the population of bonds is to relax the AER's selection criteria. Yields for individual bonds are published by CBA Spectrum, Bloomberg and UBS. The AER approach was to include only those bonds for which information was available from all three sources. ActewAGL proposed that the sample of bonds could be expanded by including bonds that appeared in *any* of the data sources, rather than restricting to those bonds that appear in *all three* data sources. The Tribunal held that the AER's rejection of this approach was unreasonable:

> the AER's decision to exclude bonds with data from less than all three sources seems to be unreasonable.[19]

61. The second means of increasing the population of bonds is to include floating rate bonds in the sample. Although what is required is an estimate of the DRP for fixed rate bonds (i.e., where the interest or "coupon" payments are fixed from the outset), it is possible to infer a fixed rate from floating rate bonds (i.e., where the interest or coupon payments vary with current market rates) and swap contracts (that convert floating payments into fixed payments). There is a well-recognised mathematical formula for doing this and ActewAGL proposed that it should be used to expand the sample of bonds. The Tribunal held that the AER's rejection of this approach was unreasonable and that it was:

> unreasonable for the AER not to include floating rate bonds in its population.[20]

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[18] Australian Competition Tribunal [2011] ACompT 4, Paragraphs 38-39.
[19] Australian Competition Tribunal [2011] ACompT 4, Paragraph 47.
[20] Australian Competition Tribunal [2011] ACompT 4, Paragraph 55.

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62. The third means of increasing the population of bonds is to include bonds with different credit ratings. ActewAGL submitted that information from bonds with A- (one notch above BBB+) and BBB (one notch below BBB+) ratings would presumably be relevant, even though it might be afforded less weight than would be applied to bonds with a BBB+ rating. The Tribunal held that the AER's rejection of this approach was unreasonable:

> The AER rejected this proposal on the basis that it would potentially give equal weight to bonds with higher and lower credit ratings than the benchmark of BBB+. We think this is too cursory a rejection of the relevance of differently rated bonds. It is one thing to hold that a differently rated bond should not be given equal weight. It is quite another to refuse to take it into account in any way.
>
> Notwithstanding the AER's rejection of the proposal to include BBB and A-bonds, the AER did consider what effect their inclusion in the population may have. The AER said that the observations showed no clear pattern. The Tribunal considers the AER's analysis to be too superficial. In fact, the longer term A- bond yields were above the CBASpectrum curve, contrary to what would usually be expected. We also consider that the AER was wrong to conclude as it did (at 56) that "[g]iven that the observed yields do not reflect reasonable expectations it is difficult to compare the selected fair value curve to the observed yields." The very fact that observed higher rated (A-) bond yields were higher than the CBASpectrum curve for lower rated (BBB+) bonds should have sent alarm signals calling for further analysis.
>
> In the Tribunal's view, if it were reasonable not to include A- and BBB bonds in the population (because they are not representative of BBB+ bonds), it was unreasonable for the AER not to consider whether useful information could be obtained from taking these bonds into account without including them in the population. That A- yields sat above BBB+ yields should have indicated to the AER that by use of its methodology it may not have selected the fair value curve most likely to provide the best estimate of the benchmark bond yield.[21]

63. The Tribunal concluded that the AER had no basis on which to reject the Bloomberg estimate and place sole reliance on the CBA Spectrum estimate. The Tribunal also held that where there is no reasonable basis for preferring one estimate to another, an average of the two would be appropriate:

> If the AER cannot find a basis upon which to distinguish between the published curves, it is appropriate to average the yields provided by each curve, so long as the published curves are widely used and market respected.[22]

64. The Tribunal finally concluded that:

> Having found that the AER fell into reviewable error, it is necessary to decide whether to remit the matter or vary the AER's decision. There is no utility in remitting the matter because, for reasons we have explained, the AER would be required to determine the relevant fair value estimate by taking the average of Bloomberg and CBASpectrum curves.[23]

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[21] Australian Competition Tribunal [2011] ACompT 4, Paragraphs 61-63.
[22] Australian Competition Tribunal [2011] ACompT 4, Paragraph 78.
[23] Australian Competition Tribunal [2011] ACompT 4, Paragraph 80.

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Appendix 2: Summary of Jemena Case

Background and context

65. Jemena Gas Networks (NSW) Ltd (**Jemena**) sought a review in relation to debt risk premium subsequent to the Tribunal's decision in relation to the ActewAGL case. Jemena had originally proposed to estimate the DRP by taking an average of the CBA Spectrum and Bloomberg estimates, which was consistent with the regulatory precedent at the time. The AER rejected that proposal and instead proposed to use the CBA Spectrum curve only, based on the same reasoning as it had relied upon in the ActewAGL Case. This all occurred prior to the Tribunal publishing its findings in relation to the ActewAGL Case.

66. Once the issue was before the Tribunal, and with the benefit of seeing the Tribunal's reasons in the ActewAGL Case, the parties made submissions on what was the best way of estimating DRP given all of the information then available.

67. The AER accepted that, in light of the Tribunal's decision in the ActewAGL Case, its determination on DRP in the Jemena Case was in error. The AER then contended that it should now use an average of the Bloomberg and CBA Spectrum estimates to be consistent with the ActewAGL decision. Jemena contended that an average is only appropriate when there is no reasonable basis for distinguishing between the two estimates, and that the available data, when properly examined, did provide a reasonable basis for preferring the Bloomberg estimate.

68. Jemena further argued that when a broad sample of bonds was examined, particularly longer-dated bonds, it was clear that the Bloomberg fair value curve provided a materially better fit to the available data than the CBA Spectrum curve. Consequently, Jemena proposed that the DRP should be based solely on the Bloomberg curve. The Tribunal noted that at the time of the Jemena determination:

> the debt risk premium of 2.93% produced by the application of the AER methodology is anomalously low and amounted to a very significant decline since late 2009 and a divergence from the figure produced by using the Bloomberg curve.[24]

Issues and Tribunal findings

69. The AER's argument was that there was no reasonable basis for distinguishing between the two fair value curves and that an average was therefore appropriate. The basis for this argument was two expert reports:

    a) A report by Associate Professor Handley that concluded that non-standard bonds should be removed from the sample. This left a smaller sample of bonds from which it was impossible to make a firm conclusion about which curve provided a better fit to the available data; and

    b) A report by Professor McKenzie that applied statistical tests and concluded that there was no statistically significant difference in the ability of each of the curves to fit the data.

70. The Tribunal concluded that it was important to use the largest possible number of bonds to obtain the most reliable results. This means that non-standard bonds should be included in the sample and

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[24] Australian Competition Tribunal [2011] ACompT 10, Paragraph 21.

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appropriate adjustments made, where the required adjustments are well-known and quite standard. The Tribunal concluded that:

> We do not agree with Professor Handley's preferred approach to exclude non-standard bonds.[25]

71. The Tribunal rejected the statistical arguments of Professor McKenzie affording them no weight in their decision.

72. Rather, the Tribunal's decision was based on what it considered to be the most thorough and detailed analysis of the relevant data, conducted by Jemena:

> By far the most extensive empirical evaluation of these questions was carried out by Dr Hird. Each test that he conducted, based on different groups of corporate bonds and with various adjustments made for non-standard bonds, produced the same conclusion – that the Bloomberg fair value curve was clearly superior to the CBASpectrum curve in terms of providing the best fit for the observed values of yield to maturity plotted against time to maturity. The Tribunal agrees that it would not be proper to exclude bonds with non-standard features so long as adjustments are applied to adjust their yields to allow for their non-standard features, and that the process should allow for the inclusion of BBB and A- bonds as well as BBB+ bonds.[26]

73. The Tribunal then weighed up the merits of the arguments presented by each of the parties:

> In *ActewAGL* averaging of rival fair value curves was undertaken because there was no clear basis to justify a preference for one curve over the other. Here, by way of contrast, Professor Handley was somewhat equivocal in his support for the CBASpectrum curve; Dr Hird meticulously evaluated different groupings of bonds and made many adjustments to allow for non-standard bond features, and his tests clearly pointed to the superiority of the Bloomberg curve over many different iterations; and the publishers of the CBASpectrum curve have stopped producing it, citing lack of relevance to the market.
>
> In addition, Professor McKenzie based his critique of Dr Hird's statistical assessments on the assumption that the data set being considered should be treated as sample data, a proposition that we have rejected.
>
> We have discounted Professor McKenzie's observation that the population will be changing as new bonds will enter the market and existing bonds will mature. This overlooks the fact that the AER must base its decision on the population identified as at the date of its determination, and not on some unknown future group of bonds that may or may not be different from the one existing on that date.[27]

74. The final decision of the Tribunal was that Jemena had established a reasonable basis for relying on the Bloomberg estimate:

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[25] Australian Competition Tribunal [2011] ACompT 10, Paragraph 57.
[26] Australian Competition Tribunal [2011] ACompT 10, Paragraph 72.
[27] Australian Competition Tribunal [2011] ACompT 10, Paragraphs 83-85.

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We therefore find that the appropriate curve from which the debt risk premium for JGN should be calculated is the Bloomberg fair value curve. The Bloomberg fair value curve is a much better fit than the CBASpectrum curve. The latter is so poor a fit to the data that it would not even be appropriate to consider averaging it with the Bloomberg curve.[28]

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[28] Australian Competition Tribunal [2011] ACompT 10, Paragraph 86.

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Appendix 3: Summary of Prof Stephen Gray

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Academic Qualifications

1995   Ph.D. (Finance), Graduate School of Business, Stanford University.
       Dissertation Title: Essays in Empirical Finance
       Committee Chairman: Ken Singleton
1989   LL.B. (Hons), Bachelor of Laws with Honours, University of Queensland.
1986   B.Com. (Hons), Bachelor of Commerce with Honours, University of Queensland.

Employment History

2000-Present   Professor of Finance, UQ Business School, University of Queensland.
1997-2000   Associate Professor of Finance, Department of Commerce, University of Queensland and Research Associate Professor of Finance, Fuqua School of Business, Duke University.
1994-1997   Assistant Professor of Finance, Fuqua School of Business, Duke University.
1990-1993   Research Assistant, Graduate School of Business, Stanford University.
1988-1990   Assistant Professor of Finance, Department of Commerce, University of Queensland.
1987   Specialist Tutor in Finance, Queensland University of Technology.
1986   Teaching Assistant in Finance, Department of Commerce, University of Queensland.

Academic Awards

2006   Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
2002   Journal of Financial Economics, All-Star Paper Award, for Modeling the Conditional Distribution of Interest Rates as a Regime-Switching Process, JFE, 1996, 42, 27-62.
2002   Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).
2000   University of Queensland Award for Excellence in Teaching (a University-wide award).
1999   Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
1999   KPMG Teaching Prize, Department of Commerce, University of Queensland.
1998   Faculty Teaching Prize (Business, Economics, and Law), University of Queensland.
1991   Jaedicke Fellow in Finance, Doctoral Program, Graduate School of Business, Stanford University.
1989   Touche Ross Teaching Prize, Department of Commerce, University of Queensland.
1986   University Medal in Commerce, University of Queensland.

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Large Grants (over $100, 000)

- Australian Research Council Linkage Grant, 2008—2010, Managing Asymmetry Risk ($320,000), with T. Brailsford, J.Alcock, and Tactical Global Management.
- Intelligent Grid Cluster, Distributed Energy – CSIRO Energy Transformed Flagship Collaboration Cluster Grant, 2008-2010 ($552,000)
- Australian Research Council Research Infrastructure Block Grant, 2007—2008, Australian Financial Information Database ($279,754).
- Australian Research Council Discovery Grant, 2006—2008, Capital Management in a Stochastic Earnings Environment ($270,000).
- Australian Research Council Discovery Grant, 2005—2007, Australian Cost of Equity.
- Australian Research Council Discovery Grant, 2002—2004, Quantification Issues in Corporate Valuation, the Cost of Capital, and Optimal Capital Structure.
- Australian Research Council Strategic Partnership Grant, 1997—2000, Electricity Contracts and Securities in a Deregulated Market: Valuation and Risk Management for Market Participants.

Current Research Interests

Benchmark returns and the cost of capital. Corporate Finance. Capital structure. Real and strategic options and corporate valuation. Financial and credit risk management. Empirical finance and asset pricing.

Publications

Chen, E. T., S. Gray and J. Nowland, (2012), "Multiple founders and firm value" *Pacific Basin Finance Journal*, forthcoming.

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Brailsford, T., S. Easton, P.Gray and S. Gray, (1995), "The Efficiency of Australian Football Betting Markets," *Australian Journal of Management*, 20(2), 167-196.

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Gray, S. (1988), "The Straddle and the Efficiency of the Australian Exchange Traded Options Market," *Accounting Research Journal*, 1(2), 15-27.

Teaching

Fuqua School of Business, Duke University, Student Evaluations (0-7 scale):

- Financial Management (MBA Core): Average 6.5 over 7 years.
- Advanced Derivatives: Average 6.6 over 4 years.
- Empirical Issues in Asset Pricing: Ph.D. Class

1999, 2006   Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.

UQ Business School, University of Queensland, Student Evaluations (0-7 scale):

- Finance (MBA Core): Average 6.6 over 10 years.
- Corporate Finance Honours: Average 6.9 over 10 years.

2002   Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).
2000   University of Queensland Award for Excellence in Teaching.
1999   Department of Commerce KPMG Teaching Prize, University of Queensland.
1998   Faculty Teaching Prize, Faculty of Business Economics and Law, University of Queensland.
1998   Commendation for Excellence in Teaching, University-wide Teaching Awards, University of Queensland.
1989   Touche Ross Teaching Prize, Department of Commerce, University of Queensland.

Board Positions

2002 - Present: Director, Financial Management Association of Australia Ltd.
2003 - Present: Director, Moreton Bay Boys College Ltd. (Chairman since 2007).
   2002 - 2007: External Risk Advisor to Board of Enertrade (Queensland Power Trading Corporation Ltd.)

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Managing Director, Strategic Finance Group: www.sfgconsulting.com.au.

Consulting interests and specialties, with recent examples, include:

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    ⇒ **Listed multi-business corporation:** Detailed financial modeling of each business unit, analysis of corporate strategy, estimation of effects of alternate strategies, development of capital allocation framework.

- **Capital management and optimal capital structure**
    ⇒ **State-owned electricity generator:** Built detailed financial model to analyze effects of increased leverage on cost of capital, entity value, credit rating, and stability of dividends. Debt of $500 million issued.

- **Cost of capital**
    ⇒ **Cost of Capital in the Public Sector:** Provided advice to a government enterprise on how to estimate an appropriate cost of capital and benchmark return for Government-owned enterprises. Appearance as **expert witness** in legal proceedings that followed a regulatory determination.
    ⇒ **Expert Witness:** Produced a written report and provided court testimony on issues relating to the cost of capital of a cable TV business.
    ⇒ **Regulatory Cost of Capital:** Extensive work for regulators and regulated entities on all matters relating to estimation of weighted-average cost of capital.

- **Valuation**
    ⇒ **Expert Witness:** Produced a written report and provided court testimony. The issue was whether, during a takeover offer, the shares of the bidding firm were affected by a liquidity premium due to its incorporation in the major stock market index.
    ⇒ **Expert Witness:** Produced a written report and provided court testimony in relation to valuation issues involving an integrated mine and refinery.

- **Capital Raising**
    ⇒ Produced comprehensive valuation models in the context of capital raisings for a range of businesses in a range of industries including manufacturing, film production, and biotechnology.

- **Asset pricing and empirical finance**
    ⇒ **Expert Witness:** Produced a written report on whether the client's arbitrage-driven trading strategy caused undue movements in the prices of certain shares.

- **Application of econometric techniques to applied problems in finance**
    ⇒ **Debt Structure Review:** Provided advice to a large City Council on restructuring their debt portfolio. The issues involved optimisation of a range of performance measures for each business unit in the Council while simultaneously minimizing the volatility of the Council's equity in each business unit.
    ⇒ **Superannuation Fund Performance Benchmarking:** Conducted an analysis of the techniques used by a large superannuation fund to benchmark its performance against competing funds.

- **Valuation of derivative securities**
    ⇒ **Stochastic Volatility Models in Interest Rate Futures Markets:** Estimated and implemented a number of models designed to predict volatility in interest rate futures markets.

- **Application of option-pricing techniques to real project evaluation**
    ⇒ **Real Option Valuation:** Developed a framework for valuing an option on a large office building. Acted as arbitrator between the various parties involved and reached a consensus valuation.
    ⇒ **Real Option Valuation:** Used real options framework in the valuation of a bio-tech company in the context of an M&A transaction.

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