

The best available empirical estimate of theta

Report prepared for Envestra

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STRATEGIC FINANCE GROUP
S F G C O N S U L T I N G

PO Box 29, Stanley Street Plaza
South Bank QLD 4101
Telephone +61 7 3844 0684
Email s.gray@sfgconsulting.com.au
Internet www.sfgconsulting.com.au

Level 1, South Bank House
Stanley Street Plaza
South Bank QLD 4101
AUSTRALIA

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Executive summary and conclusions

Instructions

1. The Strategic Finance Group: SFG Consulting (SFG) has been engaged by Envestra Ltd. to provide an expert opinion about what I consider to be the best presently available empirical estimate of theta using:
 - a. The variation of the dividend drop-off methodology employed by Beggs and Skeels (2006); and
 - b. Using data after July 2000.
2. This report has been prepared by Professor Stephen Gray, Professor of Finance at the University of Queensland and Managing Director of the Strategic Finance Group. A copy of my CV is attached as an appendix to this report. I have been provided with a copy of the Federal Court Guidelines for Expert Witnesses and have prepared this report in accordance with them. I understand that Envestra Ltd. will submit this report to the AER as part of its regulatory proposal.

Conclusions

3. In a number of recent submissions to the AER, I have provided estimates of theta that have been produced using the Beggs and Skeels methodology applied to post July 2000 data. My estimate of theta using this approach is 0.23. There are three reasons why it remains my view that this is currently the best available and most reliable among this class of estimates:
 - a. My data set extends to September 2006, whereas the Beggs and Skeels (2006) estimate is based on data through to May 2004 only. Consequently, my estimate is based on a larger data set, which generally improves the reliability of empirical estimates;
 - b. My data and computer code have been made available to the AER and its consultants who have replicated my results. By contrast, the Beggs and Skeels data and computer code has not been independently verified or made available to any other parties; and
 - c. Associate Professor Skeels, one of the authors of Beggs and Skeels (2006), has conducted a thorough examination and concluded that the SFG estimate of 0.23 is the best available estimate.

Overview of report

4. Since the submission of my first report on this issue, the AER has raised various concerns with the SFG data. Each time, the concern has been addressed by SFG either by removing any observations in question or by conducting a sensitivity analysis to demonstrate that the results are robust. In the remainder of this report I set out a chronology of the SFG reports submitted on this issue, the concerns expressed by the AER, and the way in which those concerns were addressed.

Applicability of estimates to gas distribution

5. The SFG study described below was developed as part of the regulatory process for electricity distribution determinations. In my view, it applies equally to gas distribution determinations as the estimate of theta is a market-wide parameter and is not specific to the type of business being

regulated. I note that the AER agreed with this view in its WACC Parameter Review Final Decision:

The AER considered that the other aspect of this parameter, that is the utilisation rate [θ], is a market-wide parameter.¹

SFG Report 1, 16 September 2008

6. The first SFG report in relation to gamma is dated 16 September 2008 and is titled *The effect of franking credits on the cost of capital of Australian firms* (Report 1). This report was prepared for the Joint Industries Associations (JIA) as part of the AER's Review of WACC Parameters, which ultimately led to the AER's Statement of Regulatory Intent (SoRI).
7. My approach in that report was to apply different variations of the dividend drop-off methodology to different sub-sets of data. Specifically, I applied the methodologies of:
 - a. Beggs and Skeels (2006);
 - b. Hathaway and Officer (2004); and
 - c. ACG (2006)to different time periods of data and sub-samples that included or excluded observations that were identified as outliers using Cook's D statistic.
8. In drawing conclusions, my approach was to consider the results collectively rather than selecting a particular methodology and a particular time period on which to focus. My findings were that:
 - a. The results become materially more stable and economically reasonable if a small number of outlier data points are filtered out of the sample;
 - b. The results become materially more stable and economically reasonable if a larger data set is used (a property that applies generally when estimating parameters from economic data); and
 - c. There is no material change in the estimates before and after the introduction of the Rebate Provision in July 2000.
9. Consequently, I placed more weight on results from a longer time period (using data from before and after July 2000) and after the filtering of a small number of data points.
10. My final conclusion was (p. 63) that, conditional on cash dividends having an estimated value of between 75 and 90 cents per dollar, the estimate of theta is up to about 30 cents per dollar.

¹ Review of WACC Parameters, Final Decision, p. 68.

AER WACC Review Draft Decision (Explanatory Statement)

11. In its WACC Review Draft Decision, the AER set out a number of reasons for rejecting the estimates that were presented in the first SFG report. The primary reason was that “the results cannot be verified. Therefore the results have not been considered further at this stage.”²
12. The WACC Review Draft Decision also indicated the AER’s strong preference for the use of the Beggs and Skeels version of the methodology and the exclusive use of data after July 2000.

SFG Report 2, 1 February 2009

13. The second SFG report in relation to gamma is dated 1 February 2009 and is titled *The value of imputation credits implied by the methodology of Beggs and Skeels (2006)* (Report 2). This report was prepared for the Joint Industries Associations (JIA) in response to the AER’s Review of WACC Parameters Draft Decision.
14. Given the AER’s expressed preferences in relation to the estimation of theta, SFG was retained by the JIA to prepare a revised report that uses only the Beggs and Skeels methodology applied to data post July 2000.
15. I present estimates of the value of cash dividends and theta before and after filtering out a small number of influential outliers based on Cook’s D statistic. My results are:
 - a. Including outliers: Cash dividends = 0.91; theta = 0.37; and
 - b. Excluding outliers: Cash dividends = 0.92; theta = 0.24.
16. At this point, I also supplied the AER with all of the data and computer code that was used to produce all of my estimates. I also offered to answer any questions they may have in relation to this and to change or modify the code or the data that is used as directed by the AER. No such requests have ever been made by the AER.

AER WACC Parameter Review Final Decision

17. In its *Final Decision*, the AER concludes that:

² Explanatory Statement, p. 328.

Despite the advantage of providing more up-to-date estimates (i.e. to 2006), the AER has concerns regarding the reliability of the SFG study, and considers that correction of identified deficiencies would likely have a material impact on the results. Accordingly while the AER has given full consideration to the SFG study, limited weight has been placed upon theta estimates generated by the SFG study for the purposes of this final decision... Based on the empirical evidence available, the AER considers that the 2006 Beggs and Skeels study provides the most comprehensive, reliable and robust estimate of theta inferred from market prices in the post-2000 period. It is also an independent published study that has been through the academic refereeing process. Accordingly the AER has placed significant weight on the 2001-2004 estimate of theta from this study of 0.57.³

18. The concerns and deficiencies that were specifically identified by the AER were:
- a. It was unclear whether stock price changes were adjusted for stock market movements over the ex-dividend day, as was done in Beggs and Skeels;
 - b. The company tax rates used by SFG did not correspond exactly to the official period over which those tax rates applied for the purposes of dividend imputation;
 - c. The SFG study is prone to the statistical problem of multicollinearity;
 - d. The SFG results do not correspond exactly to the Beggs and Skeels results for the corresponding period;
 - e. It was unclear whether stock splits and bonus issues were properly controlled for;
 - f. It is unclear whether announcements made by companies around the ex-dividend period might have an effect on the results;
 - g. Some observations identified by the AER using an alternative data source were not included in the SFG data set.

Skeels Review

19. Subsequent to the AER's *Final Decision*, Associate Professor Chris Skeels (one of the authors of Beggs and Skeels, 2006) was engaged to perform a thorough peer review of the SFG study and of the AER's concerns with and criticisms of it. Skeels (2009) notes that:

³ Final Decision, p. 447-448.

Many of the criticisms raised by the AER were little more than allusions to potential problems with the SFG analysis. In some cases I found that these allusions were ill-founded and readily dismissed. In other instances the appropriate response was to rework the model and to actually establish whether the concern was valid or not. This latter class of concerns was incorporated into the questions posed to SFG. I found their responses to be convincing in as much as the potential problems were demonstrated to have little or no material impact upon the results.⁴

20. In response to a number of questions from Skeels, SFG was instructed to make certain modifications to my estimation methodology. For example:
- a. I re-calibrated the corporate tax change dates to properly reflect the official period over which those tax rates applied for the purposes of dividend imputation;
 - b. I eliminated the use of Cook's D statistic as the basis for filtering outliers and instead manually checked a number of apparent outliers, eliminating only those for which there was a sound economic reason (such as a stock split);
 - c. I re-scaled the drop-off values to reflect stock market movements over the ex-date.
21. I then produced a revised set of estimates for which the estimate of theta is 0.23 (compared with my previous estimate of 0.24).
22. Professor Skeels then concludes that:

I find that the results presented in Appendix I constitute an empirically valid study of the dividend drop-off problem for Australia and that the SFG estimate of theta of 0.23 represents the most accurate estimate currently available.⁵

SA Draft Decision

23. In its SA Draft Decision, and notwithstanding the advice from Skeels, the AER concludes (p. 266) that:
- Overall the AER considers that the further work by Skeels and SFG does not address all of the concerns raised by the AER during the WACC review about the 2008 SFG study.
24. The SA Draft Decision further sets out a number of specific reasons for the AER's continued outright rejection of the SFG study as follows:
- a. Incorrect corporate tax rates used;
 - b. No test or adjustment for multicollinearity;

⁴ Skeels (2009), p. 5.

⁵ Skeels (2009), p. 5.

- c. Concerns about the reliability of some data;
- d. Filtering, outliers and the stability of estimates;
- e. Failure to remove “Black Friday” like observations from the data set.

SFG Report 3, 13 January 2010

- 25. The third SFG report in relation to gamma is dated 13 January 2010 and is titled *Response to AER Draft Determination in relation to gamma* (Report 3). This report was prepared for ETSA Utilities in response to the AER’s SA Draft Decision.
- 26. That report provides specific responses to each of the AER’s remaining issues as set out in the SA Draft Decision. I note that some of these concerns (e.g., corporate tax rates) had already been specifically addressed in material before the AER at the time of its SA Draft Decision and that other concerns (e.g., Black Friday) are nonsensical.
- 27. The third SFG report also contains an audit of a random sample of observations to further examine the reliability of the SFG results. I examined in detail a random sample of 150 observations. I cross-referenced every aspect of the data (share prices, dividend amount, ex-dates, etc) to alternate data bases to confirm that the details were correct in all respects. I also examined all company announcements around the ex-date for any hint of a price sensitive announcement that might affect the stock price. In this respect I was deliberately very conservative and included 14 observations that could even remotely possibly have contained price-sensitive announcements. I then re-computed the results without these observations and the final results were almost identical.
- 28. My conclusion from this report is that the estimate of 0.23 is robust to all of the concerns set out in the AER’s SA Draft Decision.

SFG Report 4, 4 February 2010

- 29. The fourth SFG report in relation to gamma is dated 4 February 2010 and is titled *Further analysis in response to AER Draft Determination in relation to gamma* (Report 4). This report was prepared for ETSA Utilities in response to the AER’s SA Draft Decision.
- 30. This report responds to an email to ETSA Utilities dated 21 January 2010 in which the AER sets out an itemized list of its particular concerns with the SFG study. The AER’s concerns affect an extremely small proportion of the data set and can be categorised as:
 - a. special dividends – the AER notes that Beggs and Skeels (2006) eliminated special dividends from their sample but that they are included in my sample;
 - b. stock splits and bonus issues – the AER listed seven firms which were subject to stock splits and bonus issues, which change the number of shares on issue;
 - c. contemporaneous price-sensitive announcements – the AER identified three instances in which a firm made a contemporaneous price-sensitive announcements;

- d. missing observations – the AER noted two firms which generally pay dividends but which appear infrequently in my sample; and
 - e. thin trading – the AER identified one firm which is generally thinly traded.
31. In response to the list of concerns provided by the AER, I performed a range of investigations. This has led us to add a small number of data points to my sample and to revise a small number of existing data points. I show that none of this has any material effect on my results.
32. I also present estimates for a sample that excludes all special dividends and show that the estimate of theta falls to 0.14 if all special dividends are excluded.

SA and QLD Final Decisions

33. The QLD and SA Final Decisions now set out two reasons for the AER’s rejection of the SFG study:⁶
- a. The AER concludes that “within the same sub-sample period of 1 July 2000 to 1 May 2004, the SFG study produces significantly different results to the Beggs and Skeels (2006) study. For this reason the AER considers that the SFG study’s methodology is likely to materially differ substantially from Beggs and Skeels’ (2006) methodology;” and
 - b. The AER cites a new set of empirical issues raised in a new report by McKenzie and Partington.⁷

SFG Response

34. My response to the AER’s claim that “within the same sub-sample period of 1 July 2000 to 1 May 2004, the SFG study produces significantly different results to the Beggs and Skeels (2006) study” is that:
- a. The SFG report of 1 February 2009 shows that the SFG estimates of theta and the value of cash dividends are *not* statistically significantly different from the corresponding estimates in Beggs and Skeels (2006);
 - b. There is no need for the AER to *infer* anything about the methodology employed in the SFG study. The AER has been supplied with all of the computer code used in the SFG study and has had this reviewed by its consultants. Moreover, Skeels himself has attested to the robustness of the SFG work; and
 - c. Even if the SFG results *were* different from the Beggs and Skeels results, this does not, in itself, imply that the SFG results should be given no weight. The Beggs and Skeels data and computer code have not been reviewed by anyone (including any journal referee) whereas every data point and all of the computer code for the SFG study has been made available to the AER.

⁶ QLD Final Decision, pp. 224-225.

⁷ SA Final Decision, pp. 152-161.

35. My response in relation to the issues raised in the McKenzie and Partington report are set out in the following section.

Issues raised in the McKenzie and Partington report

36. The remainder of this subsection examines each of the issues raised in the McKenzie and Partington report in turn.

Zero drop-offs

37. McKenzie and Partington note that the raw data sample used by SFG contains 177 (out of more than 3,000) observations where the price does not change over the ex-dividend date. That is, the last traded price prior to the ex-date and the closing price on the ex-date are the same. McKenzie and Partington state (p. 38) that this is “higher than would be expected.”
38. The first point to note here is that no empirical evidence has been provided to support the contention that this figure is “higher than would be expected” or “abnormally high.” Logically, there are two possibilities here:
- There are errors in the SFG data; or
 - McKenzie and Partington’s expectation about the likely number of zero drop-offs (the basis for which is never explained) is lower than that which occurs in the actual data.
39. The second point to note is that McKenzie and Partington have all of the SFG data. They have a full description of the details of all of the 177 observations in question. It would be a simple task for them to check to determine whether any of these 177 observations are in error. It would have been even simpler for the AER to have asked McKenzie and Partington to perform this task. No error in the SFG data has been identified.

Negative drop-offs

40. McKenzie and Partington also note (p.38) that the raw data sample used by SFG contains 433 negative drop-offs. This occurs when the stock price increases over the ex-dividend date. On average, one would expect the stock price to decline on the ex-dividend date, as the dividend separates from the share. However, this need not occur in every case – there may be positive news in relation to the stock that more than offsets the decline that would otherwise have occurred in relation to the dividend.
41. McKenzie and Partington conclude (p. 38) that “Where the sample accorded to its theoretical ideal, there would be no negative or zero market adjusted price movements in the data” and that “their presence may act to bias the sample estimates downwards.” If this is meant to imply that one should remove them from the data set, it is exactly wrong. Removing them will *create* a bias. To see why this is the case, consider a sample of firms that all pay \$1 dividends and suppose that the expected drop-off is \$1. But also suppose that around this expected drop-off of \$1, there is some purely random event that causes the actual drop-off to differ from the expected drop-off by an amount ε , so that the actual drop-off is:

$$\text{Actual Drop - off} = \text{Expected Drop - off} + \varepsilon .$$

42. Now suppose that ε is equally likely to take the value of -2, -1, 0, 1, or 2, in which case it has an expected value of zero which is consistent with it being purely random noise. In this case, 20% of the sample will have an observed drop-off of -1 (i.e., the expected drop-off of 1 and a random error of -2), 20% of the sample will have an observed drop-off of 0 (i.e., the expected drop-off of 1 and a random error of -1), and so on. The average actual drop-off will be:

$$\text{Average Actual Drop - off} = 0.2 \times -1 + 0.2 \times 0 + 0.2 \times 1 + 0.2 \times 2 + 0.2 \times 3 = 1,$$

so the average actual drop-off provides an accurate and unbiased estimate of the expected drop-off.

43. Now consider what would happen if zero and negative drop-offs were eliminated from the sample. In the example above, 40% of the sample would be eliminated and the average actual drop-off of the remaining observations will be:

$$\text{Average Actual Drop - off} = 0.33 \times 1 + 0.33 \times 2 + 0.33 \times 3 = 2,$$

and the estimate is biased upward.

44. This might explain why (p. 10) the estimates obtained by Truong and Partington (2006) are “higher than in most ex-dividend studies.”

Summary of conclusions on negative and zero drop-offs

45. As set out above, it would be wrong to routinely omit zero or negative drop-off observations. Such observations should only be omitted if they are erroneous, and there is no evidence of that. Moreover, Beggs and Skeels do not report the extent of negative and zero drop-offs in their study, so there is no basis for preferring the Beggs and Skeels study to the SFG study on this issue.

Intercepts

46. McKenzie and Partington (p. 50) state that “In theory, the regression equation intercept term in a dividend drop off study may be zero or negative...” McKenzie and Partington have been provided with every data item and the full set of computer code that produced the SFG estimates. They state (p. 50) that their replication of the SFG results “provides clear evidence that the intercept coefficients are statistically significant and vary in sign. The presence of positive and significant intercepts is unexpected based on a-priori theory...” and that “SFG do not report their intercept coefficients in their output tables.”
47. The implication that the SFG study had hidden the existence of a positive intercept is odd, given that all of the data and computer code had been supplied to the AER, along with repeated offers to answer any questions or address any concerns that the AER or its consultants might have had. SFG do not report intercept values because Beggs and Skeels do not report intercept values.
48. The positive intercept term that is “unexpected based on a-priori theory” relates to data from prior to July 2000. All of the intercept terms from the analysis of post 2000 data are negative. The latest estimates that were provided to the AER appeared in the SFG Report of 4 February 2010. That report contained two tables. In each table, the post July 2000 estimates are shaded in grey. The intercept values for each case are set out in the tables below.

Table 1. No additional observations eliminated because of contemporaneous price-sensitive information

	January 2010 submission (middle column) Intercept (Standard error)	Correction of 1 dividend and addition of 14 missing observations Intercept (Standard error)	Elimination of 130 special dividends Intercept (Standard error)
<u>Panel (i): SIRCA reported A\$ dividend estimates</u>			
1 Jul 00 – 30 Sep 06	-0.00759 (0.00229)	-0.00776 (0.00228)	-0.00872 (0.00230)
<u>Panel (ii): A\$ dividend estimates derived from RBA reported exchange rates</u>			
1 Jul 00 – 30 Sep 06	-0.00757 (0.00229)	-0.00776 (0.00228)	-0.00868 (0.00230)

Table 2. Additional observations eliminated because of contemporaneous price-sensitive information

	January 2010 submission (middle column) Intercept (Standard error)	Correction of 1 dividend and addition of 14 missing observations Intercept (Standard error)	Elimination of 130 special dividends Intercept (Standard error)
<u>Panel (i): SIRCA reported A\$ dividend estimates</u>			
1 Jul 00 – 30 Sep 06	-0.00750 (0.00230)	-0.00746 (0.00228)	-0.00835 (0.00230)
<u>Panel (ii): A\$ dividend estimates derived from RBA reported exchange rates</u>			
1 Jul 00 – 30 Sep 06	-0.00748 (0.00230)	-0.00744 (0.00229)	-0.00831 (0.00231)

49. All of the intercepts for the relevant period are negative and statistically significant. This operates to *increase* the combined value of dividends and franking credits.

Filtering of outliers

50. McKenzie and Partington (pp. 40-50) discusses the use of Cook's D statistic to filter out a small number of influential outliers. McKenzie and Partington conclude that "where the decision is made to eliminate outliers, it is appropriate that those outliers be identified ex-ante using an economic criteria. In attempting to account for one potential form of bias, the arbitrary application of techniques, such as Cook's, may have the unintended consequence of introducing another form of bias to the analysis."
51. Cook's D statistic is one of a number of standard statistical techniques for identifying influential outliers in a data set. It is easy to implement and transparent, but it is not the only possible means of filtering outliers. McKenzie and Partington prefer "ex ante economic criteria." In this regard, Appendix 2 of Beggs and Skeels (2006) sets out the criteria that they adopted as follows:
- Small firms (less than 0.03% of the capitalization of the market index) are filtered out;
 - Observations for which capitalization change occurred within five days of the ex-dividend date are filtered out;

- c. Special dividends are filtered out;
 - d. Ex-dividend dates in October 1987 are filtered out (although this is not relevant as the focus is on post-2000 data in this case).
52. All of the SFG dividend drop-off analyses filter out small firms (using the same definition as used by Beggs and Skeels) and firms for which there was a capitalization change. I have subsequently provided the AER with estimates including and excluding special dividends.⁸
53. I have also provided the AER with estimates that do not filter outliers based on the Cook's D statistic. Rather, I identify influential outliers and then examine each identified point individually. This examination involves manual checking of every identified data point for errors in the dividend record (cross-referencing dividend amounts and ex dates to alternative data sources) and for possible price sensitive announcements close to the ex-dividend date. I then only filtered out observations that were identified as potentially contaminated in some way. This analysis was provided to the AER in my report of 4 February 2010. It confirms the robustness of my theta estimate of 0.23 when special dividends are included. The removal of special dividends from the sample results in a lower estimate of theta of 0.13.

Miscellaneous data issues

54. McKenzie and Partington (pp. 18-24) set out a number of miscellaneous data issues as follows:
- a. Dividend announcements and ex-dates tend to be clustered in time;
 - b. Thinly traded stocks may not fully reflect market valuation;
 - c. Bid-ask spreads may affect the measurement of returns; and
 - d. Price sensitive information may affect returns.
55. The time clustering of dividend ex-dates is, of course, equally an issue for all dividend drop-off studies, including Beggs and Skeels. There is no a priori reason to expect that any such time clustering of dividends in certain months of the year would systematically impact estimates of theta from dividend drop-off studies, or whether any impact that might exist would have a positive or negative effect on the estimate of theta.
56. The other three issues apply whenever stock market data is used – they apply whenever returns are being measured. Consequently, these issues apply equally to estimates of beta and market risk premium. One can either recognise the potential for these issues to arise and take actions to mitigate their effect (e.g., by using a large sample to average out or dampen any noise that might arise from these issues) or select parameter values by assumption, without reference to market data.
57. In summary:
- a. None of these issues is unique to the SFG study – they all apply equally to Beggs and Skeels (2006) and many of these issues applies also to estimates of beta and MRP; and

⁸ SFG Report of 4 February 2010, set out in Paragraph 32 above.

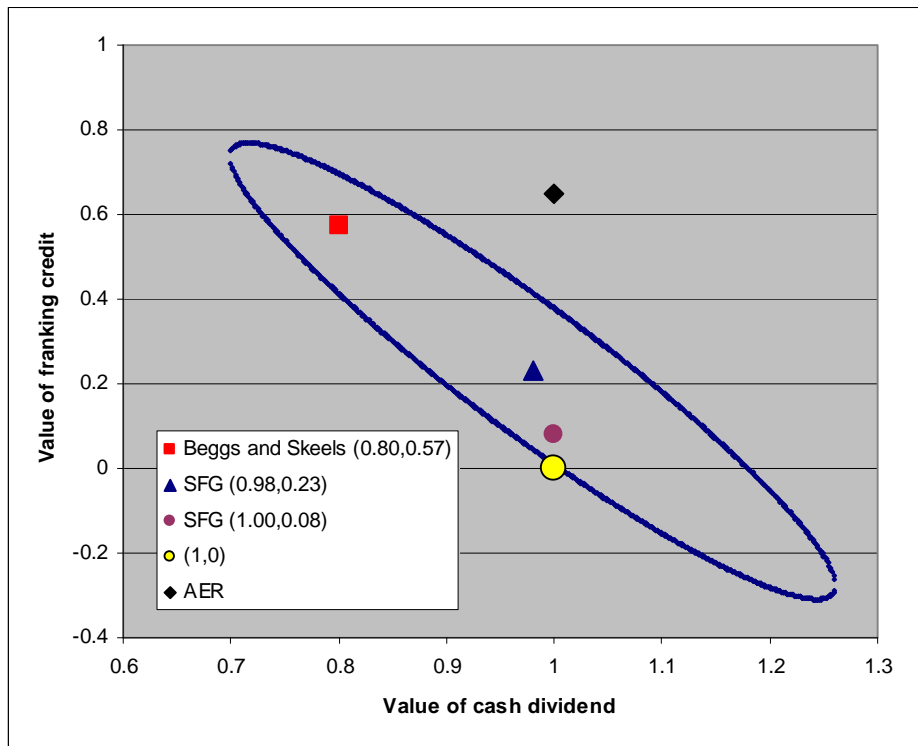
- b. The SFG study uses a larger (more recent) sample of data than that used by Beggs and Skeels and is consequently less susceptible to the effects set out above to the extent that noise is more likely to cancel out in a larger sample.

Multicollinearity

58. I have previously addressed the issue of multicollinearity in my report of 7 December 2009, submitted on behalf of ENERGEX Ltd and Ergon Energy.
59. In that report, I noted that if multicollinearity is an issue for the SFG study, it is equally an issue for the Beggs and Skeels study, which employs the same empirical methodology applied to the same type of data. I now note that McKenzie and Partington (p. 46) reach the same conclusion.
60. In my report of 7 December 2009 I also set out an approach that addresses multicollinearity. That approach is based around a joint confidence interval for the two parameters in question. If multicollinearity is an issue, it is difficult to separately estimate each individual parameter, but the combined effect of the two parameters can be reliably estimated. The joint confidence interval quantifies the combined effect of the two parameters and shows the pairs of parameter estimates that fit the data equally well (in a statistical sense). My conclusion is that any of the pairs of values within the joint confidence region could be used (because the data is unable to statistically distinguish between them), but that whatever pair of values is used must be used consistently throughout the WACC estimation exercise.
61. McKenzie and Partington reproduce my joint confidence interval, but make no comment about whether or not they agree with this approach. In fact, McKenzie and Partington provide no suggestions for how multicollinearity might be addressed. They set out (on p. 46 of their report) a summary of how multicollinearity might be addressed in other settings, but conclude that none of these approaches can or should be used in the case at hand. The SFG study remains the only dividend drop-off analysis that addresses the possibility of multicollinearity.

Pairs of estimates and the joint confidence interval

62. The SFG joint confidence interval is reproduced below.



63. What this joint confidence interval shows is *pairs* of estimates that jointly fit the data just as well as each other. That is, the Beggs and Skeels estimates of 0.80 for cash dividends and 0.57 for theta fits the data just as well as the SFG estimate of 0.98 for cash dividends and 0.23 for theta. The data is unable to distinguish between these two pairs of estimates, so on that basis there would be justification for using either pair of estimates throughout the WACC estimation process.
64. But that is not what the AER has done throughout this regulatory process. Rather, the AER ignores the estimate of the value of cash dividends and instead imposes its assumption that cash dividends are valued at 100% of face value. That is, the AER never uses the *pair* of estimates, it only uses the estimate of theta. The AER sets the value of cash dividends to be 100% of face value in two places in the WACC estimation process:
- The AER uses the CAPM to estimate the required return on equity. The CAPM produces an estimate of the required return on equity based on dividends being valued at 100% of face value. There are variations of the CAPM that allow for dividends to be valued at less than 100% of face value, but the version adopted by the AER is based on dividends being valued at 100% of face value. This is also recognised by Handley (2010, p.24; 2009, p. 29); and
 - The building block approach in the Post-Tax Revenue Model is based on dividends being valued at 100% of face value. Specifically, the annual revenue requirement is set so that the residual cash flow that is available to be distributed to shareholders as a dividend is valued at 100% of face value. There is no recognition that this cash flow might be valued at less than 100% of face value, whereas there is such recognition that franking credits are valued by investors at less than face value.

65. In summary, the combination of the pair of results is not statistically significantly different from zero. This means that if one were using the *pair* of results, either pair would do – at least as far as statistical significance goes. But if only one component of the result is being used (i.e., theta) and the other component is being ignored, the statistical significance of the pair is irrelevant, and one would only be concerned about the statistical significance of the single component that is being used.
66. The results of statistical significance tests of each of the individual estimates is as follows:
- a. The SFG estimate of theta of 0.23 *is* statistically significantly different from the Beggs and Skeels estimate of 0.57 with probability greater than 99% (p-value is 0.0085);
 - b. The SFG estimate of the value of cash dividends of 0.98 *is* statistically significantly different with probability greater than 99% (p-value is 0.0011).
67. The AER's approach, which is indicated as a black diamond in the figure above, is statistically significantly different from the results of both SFG and Beggs and Skeels.
68. In summary, the joint confidence interval identifies *pairs* of estimates that fit the available data equally well. On this basis, one would be justified in taking any statistically equivalent pair of estimates and applying that pair of estimates consistently throughout the WACC estimation process. But the AER's approach has been to adopt the Beggs and Skeels estimate of theta (0.57) but to reject the corresponding Beggs and Skeels estimate of the value of cash dividends (0.80) in favour of an inconsistent estimate of the value of cash dividends (1.00). The resulting pair of estimates adopted by the AER (1.00, 0.57) is statistically significantly inferior in fitting the available data relative to either the Beggs and Skeels pair of estimates (0.80, 0.57) or the SFG pair of estimates (0.98, 0.23).

Declaration

69. In preparing this report, I have made all the enquiries that I believe are desirable and appropriate and no matters of significance that I regard as relevant have, to my knowledge, been withheld from the Court.



Professor Stephen Gray
27 September, 2010.

References

- Australian Energy Regulator (2008), “Electricity transmission and distribution network service providers – Review of the weighted-average cost of capital (WACC) parameters: Explanatory statement,” December, www.aer.gov.au/content/index.phtml/itemId/722190.
- Australian Energy Regulator (2009), “Electricity transmission and distribution network service providers – Review of the weighted-average cost of capital (WACC) parameters: Final Decision,” May, www.aer.gov.au.
- Australian Energy Regulator (2009), “Draft decision: Queensland distribution determination 2010-11 to 2014-15,” www.aer.gov.au.
- Beggs, D. J. and Skeels, C.L., (2006), “Market arbitrage of cash dividends and franking credits,” *Economic Record*, 82 (258), 239 – 252.
- Greene, W.H., (2003), *Econometric Analysis*, 2nd. ed., MacMillan.
- Hathaway, N., & Officer, R.R., (2004), “The Value of Imputation Tax Credits Update 2004,” Capital Research Pty Ltd.
- McKenzie, M., and G. Partington, (2010), “Evidence and Submissions on Gamma,” www.aer.gov.au.
- Skeels, C., 2009, “A review of the SFG dividend drop-off study,” *Submission to AER on behalf of ETSA Utilities*, 28 August.
- Strategic Finance Group: SFG Consulting (2009), “Gamma: Further evidence to support departure from the AER’s Statement of Regulatory Intent,” December.
- Strategic Finance Group: SFG Consulting (2010), “Response to AER Draft Determination in relation to gamma: Report prepared for ETSA Utilities,” January.
- Strategic Finance Group: SFG Consulting (2010), “Further analysis in response to AER Draft Determination in relation to gamma,” February.

Summary of issues raised by the AER and steps taken to address them

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
Large standard errors	SA Draft Decision, p. 267.	<p>The standard error in the 2008 SFG study is 0.54, compared to 0.12 for Beggs and Skeels (2006) in the 1 July 2000 to 10 May 2004 sub-sample. This would suggest that the estimates in the 2008 SFG study are less statistically precise than those in the Beggs and Skeels study.</p> <p>Further, Skeels' comparison examined the differences between the Beggs and Skeels study and the unfiltered sample rather than the preferred sample from the 2008 SFG study – in other words, Skeels did not refer to the sample which used the Cook's D-statistic which removed one per cent of influential observations (theta estimate of 0.19 which an associated standard error of 0.136)</p>	Skeels (2010) SFG (2009)	<p>Addressed</p> <p>The AER's criticism is based on a particular set of SFG results which are not SFG's preferred results.</p> <p>The Beggs and Skeels standard errors should be compared with those for SFG's preferred results (SFG (2009a), Table 1, p 8). The standard errors reported in SFG's preferred results with influential (and economically unreliable) observations removed from the sample, are typically smaller than those of Beggs and Skeels (Skeels (2010), p 27).</p>
Different coefficients	SA Draft Decision, pp. 267, 269; QLD Final Decision, p. 222.	<p>The coefficients from SFG's preferred approaches are statistically different to the Beggs and Skeels coefficients.</p> <p>The AER considers it unusual</p>	Skeels (2010)	<p>Addressed</p> <p>The samples used in estimating the different results are clearly not identical, and therefore one would not expect to see identical coefficients. One difference in the data set is the fact that the</p>

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
		that three studies which use similar methodologies and are all attempting to estimate theta over the same sampling period would be found to be statistically different.		<p>Beggs and Skeels data set extends back to July 1985 whereas the SFG data set extend back as far as July 1997. It is possible that these differences in sample lengths manifest themselves in the slope coefficients via the (unreported) intercepts contained in each equation. That is, the differences in results ascribed to different samples may be manifestations of differences in the lengths of the overall samples which are used in the estimation of intercepts. (Skeels (2010), p 27).</p> <p>Also, the SFG results are <i>not</i> statistically significantly different from those reported by Beggs and Skeels for the same period. See the numbers presented in bold in Table 1 of the SFG report of 1 February 2009.</p>
Economically implausible coefficients	SA Draft Decision, p. 267	SFG (2009a) reported a point estimate for the value of cash of 1.015. The AER considers this estimate to be economically implausible.	Skeels (2010)	<p>Addressed</p> <p>The confidence interval for the value of cash derived by SFG includes economically plausible values. The correct interpretation of the estimates is that they suggest that the true parameter is near to the boundary of the range of economically plausible values. They do not suggest that the true parameter value is an economically implausible value. (Skeels (2010), p 28).</p> <p>This estimate is not statistically significantly different from 1.0 – which implies that cash dividends are valued at 100 cents in the dollar.</p>

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
				Also, Beggs and Skeels (2006) report an estimate of 1.168 for tax regime 6 in their Table 5, p.247.
Unnecessary noise	SA Draft Decision, pp. 269, 271 – 272	The data set used as an input to the SFG regression appears not to use historically consistent price and dividend data which may introduce unnecessary noise into the estimation results.	Skeels (2010) SFG (2010b)	<p>Not material, unfounded</p> <p>This issue can be illustrated via a simple example. Suppose a firm has a share price of \$10 and then pays a dividend of \$1. Then suppose it performs a 1:1 stock split so there are now twice as many shares and the share price halves. Then suppose the firm has a \$5 share price and pays a 50 cent dividend. The AER submits that the share price and the dividend should be adjusted back up to a pre-split basis. That is, we should multiply the share price and dividend by two to “undo” the effect of the stock split.</p> <p>This is nonsensical. The dividend drop-off method compares the <i>actual</i> dividend with the <i>actual</i> share price over the course of a few days at most. If a stock split (or similar event) occurs within that period, the observation is already excluded. If a stock split occurs some weeks before or after the event window it is irrelevant. In any event, scaling the dividend and stock price by the same constant would have no effect on the results anyway.</p>
Special dividends	SA Draft Decision, pp. 269 – 272.	The AER claims that SFG’s results may be affected by the inclusion of special dividends in the dataset.	SFG (2010b)	<p>Addressed</p> <p>There is no theoretical reason why special dividends should be treated differently. However, SFG reviewed all the special dividends announced to the ASX during the sample period</p>

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
				and presented results including and excluding special dividends. There were 130 special dividends in the dataset. If special dividends were excluded there was a material reduction in the estimated value of imputation credits (SFG (2010b), pp. 3-4).
Use of corporate tax rates	SA Draft Decision, pp. 269 – 272.	The AER notes a three month lag for the adoption of the 34 and 30 per cent tax rates.	Skeels (2010) SFG (2010a)	Corrected and not material This very minor error identified by the AER in the use of corporate tax rates has been addressed by SFG (Skeels (2010), p. 19). SFG states that this was a relatively small change to be applied to a relatively small proportion of the sample observations and has an inconsequential effect on the estimates (SFG (2010a), pp. 1-2). As a consequence of this change for the post-2000 sample, the point estimate of the value of franking credits changes from 0.2308 to 0.2340 (SFG (2010a), pp. 4-5).
Multicollinearity	SA Draft Decision, pp. 269 – 270, 272. SA Final Decision, p. 152.	The AER states in the Draft Decision that there have been no tests conducted to examine the extent of multicollinearity. The AER also considers multicollinearity to be a significant concern for dividend drop-off studies. Symptoms of multicollinearity	SFG (2010a) Skeels (2010)	Addressed There remains no evidence that multicollinearity is a concern for either Beggs and Skeels (2006) or SFG (2009a) (Skeels (2010), p. 18) Skeels states that he does not consider multicollinearity to be a problem affecting the SFG results (Skeels 2009a, p. 19) Even if multicollinearity is a problem of practical relevance in this case, which Skeels does not

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
		include large standard errors and estimates of theta that are statistically insignificant. The AER considers that SFG's analysis of joint confidence intervals does not address the issue of multicollinearity.		consider it is, it remains the case that OLS remains consistent and the best linear unbiased estimator. That is, within its class of estimators OLS still provides the optimal estimates with the smallest possible estimated standard errors (Skeels (2010), p. 18).
Consistency issues	SA Final Decision, p. 154.	The AER does not consider it appropriate to set the value of a dollar of cash dividends to 100 cents in the context of estimating theta using dividend drop-off studies The majority of empirical evidence from dividend drop-off studies supports a lower value for cash.	Only raised in Final Decision – no opportunity to respond	Not material, unfounded Every iteration of the SFG dividend drop-off analysis estimates theta without fixing or constraining the value of cash dividends, which is estimated as a free parameter. SFG have noted that the AER estimates the required return on equity and calculates the expected tax costs on the basis that cash dividends are valued at 100 cents per dollar. SFG submit that the AER should estimate gamma on the same basis. However, the AER has determined that it is open to it to estimate some parameters on the basis that cash dividends are fully valued and other parameters on the basis that they are materially less than fully valued. For example, the Beggs and Skeels estimate of theta of 0.57 is based on cash dividends being valued at 80 cents per dollar. (Beggs and Skeels, Table 5, p.247, last row). Consequently, SFG presents estimates that do

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
				not constrain the value of cash dividends at all. The SFG theta estimate of 0.23 is not based on a constrained value of cash dividends.
Data sampling	SA Final Decision, p 156.	The AER refers to Field's analysis, which suggests that between 198 and 530 observations are unreliable and should be excluded from SFG's data set.	Only raised in Final Decision – no opportunity to respond	Not material It is not correct to call these observations "unreliable." SFG identified all observations for which there was any announcement within five days of the ex-dividend date and showed that this is a relatively small proportion of observations. Since the drop-off method is based on the change in the stock price over the ex-date, only announcements that actually occurred on the ex-date itself could possibly affect the results. None of the identified announcements was on the ex-date itself. Even if they were, they are equally likely to have a positive or negative effect on the estimate of theta, so are unlikely to materially affect the results in a large sample.
Filtering of outliers	SA Draft Decision, pp. 267, 270. SA Final Decision, p 157.	The AER claims that the SFG analysis may be affected by influential outliers. Given that SFG has not conducted a rigorous interrogation of the data, there may be jointly influential unreliable observations within the data. The Cook's D analysis may fail to identify observations which in themselves are not influential,	Skeels (2009c) Skeels (2010)	Addressed and unlikely to be an issue The SFG (2009a) approach is similar to the Beggs and Skeels (2006) approach in that no observations are excluded other than on economic grounds. Moreover as SFG (2009) reports results from both the unfiltered and filtered samples, the reader is provided with an idea of the sensitivity of the results to their filtration process, something not provided for in Beggs and Skeels (2006) (Skeels (2009c), p. 6). In SFG's more recent work Cook's D statistic is

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
		<p>but when combined are jointly influential. Further, the use of Cook's D-statistic may introduce a bias into the SFG analysis because it only excludes individually influential observations that are economically unreliable and does not identify groups of observations that are jointly significant.</p> <p>The decision to exclude the top one percent of observations is also arbitrary.</p> <p>Before filtering SFG's data set estimated the combined value of cash dividends and imputation credits to be between -60 and 575, but after filtering the range is -60 to 55.</p> <p>Beggs and Skeels (2006) filtered data using ex ante economic criteria which is more appropriate than the SFG approach of identifying individually influential observations and only analysing these.</p>		<p>only used to identify potentially influential observations and exclusion is determined on the basis of an economic assessment of the quality of these observations – hence the exclusion of observations can no longer be thought of as arbitrary (Skeels (2009c), p. 7).</p> <p>Even though not designed for detecting groups of influential observations, Cook's D statistic may still have some success in detecting the group if it deems influential one or more of the observations in the group (Skeels (2009), p 9).</p> <p>Skeels considers it highly unlikely that such a large group of observations could be unreliable with none of them being influential singly (Skeels (2009), p. 9).</p> <p>The choice of one per cent is clearly a reflection of professional judgment and in Skeels's opinion, is neither right nor wrong. According to Skeels, there is nothing about a choice of one per cent that would unduly surprise or concern another professional (Skeels (2009c), p. 8).</p> <p>The modified procedure adopted by SFG, provides a reasonable compromise between the need to ensure that the results obtained were not driven by unreliable observations while, at the same time, avoiding the prohibitive cost associated with individually investigating every observation (Noting that Beggs and Skeels also did not perform a manual check of every</p>

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
				observation in the data base as this is prohibitively time consuming and is not standard practice in large sample empirical estimations). In this procedure, the identified influential observations were investigated and individual observations were only discarded in situations where it could be established that there was something unreliable about them. In light of the way its use has been modified by SFG, Skeels considers that the modified use of Cook's D statistic by SFG is an appropriate statistical technique for filtering the SFG data set (Skeels (2010), p. 23).
Exclusion of intercept term	SA Final Decision, p 158. McKenzie and Partington (2010)	In analysing SFG's results, McKenzie and Partington found a statistically significant intercept term that was not reported by SFG The combined value of cash dividends and imputation credits may therefore be underestimated by the coefficient estimates in the SFG study.	Only raised in Final Decision – no opportunity to respond	Not material The positive intercept term relates to data from prior to July 2000. All of the intercept terms from the analysis of post 2000 data are negative. All of the intercepts for the relevant period are negative and statistically significant.
Miscellaneous data issues	SA Final Decision, p. 158 McKenzie and Partington (2010)	SFG's data set contains a large number of zero drop-offs McKenzie and Partington noted that in SFG's unfiltered data set, 526 out of 5646 observations	SFG (2010b)	There is no evidential basis cited for the statement of McKenzie and Partington that the number of 177 out of 3,201 observations being zero observations is abnormally high. In would be incorrect to arbitrarily omit zero or

Criticism	Where raised	Summary of criticism	Where criticism is dealt with	Response
		<p>are zero observations, and in SFG's filtered data set, 177 out of 3,201 observations are zero observations. This is considered to be an abnormally high number of zero observations. McKenzie and Partington also note that almost 20 per cent of SFG's filtered data set comprise zero or negative observations.</p> <p>Additionally, the SFG analysis may not fully address the issue of thin-trading.</p>		<p>negative drop-off observations. These observations should be omitted if they are incorrect, however there is no evidence to suggest that this is the case.</p> <p>Removing zero and negative drop-offs would introduce bias into the results.</p> <p>The SFG dataset only comprises observations in which a trade could be identified as having occurred within two days of the ex-dividend date. In addition, the requirement that market capitalisation be at least 0.03 per cent of the All Ordinaries Index mitigates against the potential for thin trading to bias the results (SFG (2010b), p. 4). The approach adopted by SFG is identical to the approach adopted by Beggs and Skeels (2006).</p>

Appendix: CV of Professor Stephen Gray

Stephen F. Gray

University of Queensland
Business School
Brisbane 4072
AUSTRALIA
Office: +61-7-3346 8032
Email: s.gray@business.uq.edu.au

Academic Qualifications

- 1995** Ph.D. (Finance), Graduate School of Business, Stanford University.
Dissertation Title: Essays in Financial Economics
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.

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.

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.

Publications

Gray, S., C. Gaunt and Y. Wu, (2010), “A comparison of alternative bankruptcy prediction models,” *Journal of Contemporary Accounting and Economics*, forthcoming.

Feuerherdt, C., S. Gray and J. Hall, (2010), “The Value of Imputation Tax Credits on Australian Hybrid Securities,” *International Review of Finance*, forthcoming.

Gray, S., J. Hall, D. Klease and A. McCrystal, (2009), “Bias, stability and predictive ability in the measurement of systematic risk,” *Accounting Research Journal*, forthcoming.

Treepongkaruna, S. and S. Gray, (2009), “Information volatility links in the foreign exchange market,” *Accounting and Finance*, 49, 2, 385-405.

Costello, D., S. Gray, and A. McCrystal, (2008), “The diversification benefits of Australian equities,” *JASSA*, December.

Gray, S. and J. Hall, (2008), “The Relationship Between Franking Credits and the Market Risk Premium: A Reply,” *Accounting and Finance*, 48, 1, 133-142.

Gray, S., A. Mirkovic and V. Rangunathan, (2006), “The Determinants of Credit Ratings: Australian Evidence,” *Australian Journal of Management*, 31(2), 333-354.

Choy, E., S. Gray and V. Rangunathan, (2006), “The Effect of Credit Rating Changes on Australian Stock Returns,” *Accounting and Finance*, 46(5), 755-769.

Gray, S. and J. Hall, (2006), “The Relationship Between Franking Credits and the Market Risk Premium,” *Accounting and Finance*, 46(3), 405-428.

Gray, S. and S. Treepongkaruna, (2006), “Are there non-linearities in short-term interest rates?” *Accounting and Finance*, 46(1), 149-167.

- Gray, P., S. Gray and T. Roche, (2005), "A Note on the Efficiency in Football Betting Markets: The Economic Significance of Trading Strategies," *Accounting and Finance*, 45(2) 269-281.
- Duffie, D., S. Gray and P. Hoang, (2004), "Volatility in Energy Prices. In V. Kaminski," (Ed.), *Managing Energy Price Risk: The New Challenges and Solutions* (3rd ed.). London: Risk Books.
- Cannavan, D., F. Finn and S. Gray, (2004), "The Value of Dividend Imputation Tax Credits in Australia," *Journal of Financial Economics*, 73, 167-197.
- Gray, S. and S. Treepongkaruna, (2003), "Valuing Interest Rate Derivatives Using a Monte-Carlo Approach," *Accounting and Finance*, 43(2), 231-259.
- Gray, S., T. Smith and R. Whaley, (2003), "Stock Splits: Implications for Investor Trading Costs," *Journal of Empirical Finance*, 10, 271-303.
- Gray, S. and S. Treepongkaruna, (2003), "On the Robustness of Short-term Interest Rate Models," *Accounting and Finance*, 43(1), 87-121.
- Gray, S. and S. Treepongkaruna, (2002), "How to Value Interest Rate Derivatives in a No-Arbitrage Setting," *Accounting Research Journal* (15), 1.
- Gray, P. and S. Gray, (2001), "A Framework for Valuing Derivative Securities," *Financial Markets Institutions & Instruments*, 10(5), 253-276.
- Gray, P. and S. Gray, (2001), "Option Pricing: A Synthesis of Alternate Approaches," *Accounting Research Journal*, 14(1), 75-83.
- Dahlquist, M. and S. Gray, (2000), "Regime-Switching and Interest Rates in the European Monetary System," *Journal of International Economics*, 50(2), 399-419.
- Bollen, N., S. Gray and R. Whaley, (2000), "Regime-Switching in Foreign Exchange Rates: Evidence from Currency Options," *Journal of Econometrics*, 94, 239-276.
- Duffie, D., S. Gray and P. Hoang, (1999), "Volatility in Energy Prices. In R. Jameson," (Ed.), *Managing Energy Price Risk* (2nd ed.). London: Risk Publications.
- Gray, S. and R. Whaley, (1999), "Reset Put Options: Valuation, Risk Characteristics, and an Example," *Australian Journal of Management*, 24(1), 1-21.
- Bekaert, G. and S. Gray, (1998), "Target Zones and Exchange Rates: An Empirical Investigation," *Journal of International Economics*, 45(1), 1-35.
- Gray, S. and R. Whaley, (1997), "Valuing S&P 500 Bear Market Warrants with a Periodic Reset," *Journal of Derivatives*, 5(1), 99-106.
- Gray, S. and P. Gray, (1997), "Testing Market Efficiency: Evidence from the NFL Sports Betting Market," *The Journal of Finance*, 52(4), 1725-1737.

- Gray, S. (1996), "Modeling the Conditional Distribution of Interest Rates as a Regime-Switching Process," *Journal of Financial Economics*, 42, 27-62.
- Gray, S. (1996), "Regime-Switching in Australian Interest Rates," *Accounting and Finance*, 36(1), 65-88. 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.
- Duffie, D. and S. Gray, (1995), "Volatility in Energy Prices," In R. Jameson (Ed.), *Managing Energy Price Risk*, London: Risk Publications.
- Gray, S. and A. Lynch, (1990), "An Alternative Explanation of the January Anomaly," *Accounting Research Journal*, 3(1), 19-27.
- Gray, S. (1989), "Put Call Parity: An Extension of Boundary Conditions," *Australian Journal of Management*, 14(2), 151-170.
- 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 12 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)