Equity beta

Report prepared for APT Petroleum Pipelines Ltd

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Executive summary and conclusions

Instructions and context

1. SFG Consulting (**SFG**) has been engaged by APT Petroleum Pipelines Ltd (**APTPPL**) to consider the estimate of equity beta that is commensurate with current conditions in the market for funds and the risks involved in providing reference services under sub-Rule 87(1) of the National Gas Rules (the **Rules**).

2. The specific questions I have been asked to address are set out below. A full copy of my instructions is attached as Appendix 1 to this report.

> In calculating APTPPL's return on capital, what do you consider to be the appropriate methodology to be adopted in estimating the equity beta, and what is the appropriate value to be adopted as an estimate of the equity beta? That is, what methodology and value should be adopted that will provide an equity beta that, when used in the WACC formula, will result in a rate of return on capital that is commensurate with prevailing conditions in the market for funds and the risks involved in providing reference services. In answering these questions, please take into consideration:
>
> (a) that the AER has previously indicated, particularly in its Statement of regulatory intent on the revised WACC parameters that applies to electricity distribution businesses and its Statement of the revised WACC parameters that applies to electricity transmission businesses, that it considers 0.8 is an appropriate estimate of the equity beta for these businesses, and the basis for that estimate;
>
> (b) the methodology and data used to calculate the current regulatory estimate of 0.8 and any impact on the reliability, or otherwise, of the use of these methodology and data in estimating the equity beta;
>
> (c) any data that could be used to improve the statistical reliability when estimating the equity beta;
>
> (d) any statistical techniques that could be used to improve the reliability of estimates from the available data.

3. This report has been authored by Professor Stephen Gray. I am Professor of Finance at the UQ Business School, University of Queensland and Director of SFG Consulting. I have honours degrees in Commerce and Law from the University of Queensland and a PhD in Finance from the Graduate School of Business at Stanford University. I have extensive experience in advising companies, government, and regulatory agencies on issues relating to weighted-average cost of capital.

Declaration

4. I have been provided with a copy of the Federal Court Guidelines for Expert Witnesses and have prepared this report in accordance with them. 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.

Recent regulatory decisions

5. The Australian Energy Regulator (**AER**) has produced four recent final decisions, all of which adopt an estimate of equity beta (based on 60% gearing) of 0.8, consistent with the AER's estimate in relation to the equity beta for electricity transmission and distribution businesses in its Statement of Regulatory Intent (**SoRI**) from May 2009. Those decisions are:

   a. Final Decision: NT Gas: Access arrangement proposal for Amadeus Gas Pipeline, July 2011 (**Amadeus Pipeline Final Decision**);

   b. Final Decision: Envestra Ltd: Access arrangement proposal for the Qld gas network, June 2011 (**Qld Gas Final Decision**);

   c. Final Decision: APT Allgas Ltd: Access arrangement proposal for the Qld gas network, June 2011 (**Allgas Qld Gas Final Decision**); and

   d. Final Decision: Envestra Ltd: Access arrangement proposal for the SA gas network, June 2011 (**SA Gas Final Decision**).

This report references the SoRI and the four recent final decisions in determining an equity beta that results in an estimate of the required return on equity that is commensurate with the prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of equity.

Appropriate starting point is an equity beta estimate of 1.0

Average equity beta is 1.0

6. By definition, the average equity beta for all listed companies is 1.0. Consequently, 1.0 is the natural starting point when estimating equity betas.

No reason for a priori view that the equity beta for an electricity or gas transmission or distribution firm is less than 1.0

7. There are two things that determine the relative systematic risk, or equity beta, of a particular firm:

   a. The type of business that the firm operates; and

   b. The amount of financial leverage employed by the firm.

8. It is generally accepted that the business activities of regulated network transmission and distribution businesses have lower than average systematic risk. But it is also clear that such businesses have much higher financial leverage than the average firm. These two effects operate in different directions for regulated network businesses:

   a. Their business activities would suggest lower than average systematic risk; but

   b. Their financial leverage would suggest higher than average financial risk.

Only move from the starting point beta estimate of 1.0 if there is reason to do so

9. Since transmission and distribution businesses have business activities that are of below average risk, but financial leverage that is much higher than average, the two components of equity beta operate in different directions and will tend to offset one another. Consequently, a natural starting point when estimating equity beta is that of the average firm, which is 1.0. This was also the regulatory precedent prior to the AER's SoRI in 2009.

10. One would only move from this starting point to the extent that:

    a. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 was warranted; and

    b. The resulting equity beta value resulted in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover the efficient cost of capital.

Recent regulatory estimates vs. starting point estimate of 1.0

11. An equity beta estimate of 0.8, based on leverage of 60%, has been used in a number of recent regulatory determinations for electricity network businesses. This estimate emanates from the Review of WACC Parameter Estimates performed by the Australian Energy Regulator (**AER**) and has subsequently been adopted in recent determinations by the AER.

12. In this report, I examine the recent regulatory estimate of 0.8 in detail and consider:

    a. Whether appropriate analysis of the available data does warrant a move away from the starting point of 1.0 to an estimate of 0.8; and

    b. Whether the equity beta estimate of 0.8 produces an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

13. For the reasons set out below, I conclude that:

    a. The regulatory estimate of 0.8 is statistically unreliable such that no material weight should be applied to it; and

    b. The regulatory estimate of 0.8 produces an estimate of the required return on equity that is not commensurate with prevailing conditions in the market for funds and does not provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

14. By contrast, a beta estimate of 1.0 produces an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and does provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

Regulatory estimate of 0.8 is statistically unreliable

15. I conclude that the statistical analysis on which the regulatory estimate of 0.8 is based is so unreliable that it should be afforded little weight. The reasons for this conclusion include:

a. The data set on which it is based is so small and incomplete that no econometric technique applied to it (no matter how carefully applied) can produce estimates that are precise and reliable;

b. The individual estimates on which the AER's estimate is based are, in many cases, implausible;

c. The individual estimates on which the AER's estimate is based are inconsistent between firms and over time;

d. The AER's estimate ignores important information about the precision of beta estimates (i.e., the AER does not consider standard errors, which is inconsistent with standard statistical and econometric practice);

e. The AER's estimate ignores important information about the reliability and informativeness of beta estimates (i.e., the AER does not consider R^2 statistics, which is inconsistent with standard statistical and econometric practice);

f. The AER's estimate ignores the issue of bias in beta estimates, which is inconsistent with standard statistical and econometric practice and with the practice of commercial beta services.

Regulatory estimate of 0.8 is implausible

The approach on which the 0.8 is based produces implausible estimates over time

16. The 0.8 estimate is based on information from a very small set of comparable firms, most of which have been exchange-listed for only a short time. Consequently, it is not possible to examine what estimates of beta the empirical approach would have produced for earlier periods of time. However, when this approach is applied to other industries, it produces estimates that vary so wildly over time that those estimates cannot possibly be a reliable reflection of systematic risk.

The required return on equity cannot be materially lower than the return on equity that investors could reasonably expect to receive from comparable firms

17. An important consideration when determining whether a proposed regulatory return on equity, r_e, is consistent with the Rules is a comparison between that allowed regulatory return on equity and the return on equity that investors might reasonably expect to receive from comparable firms. If the reasonably expected return on equity in the comparable firms is materially higher than the allowed return on equity for the regulated firm, there must be questions about the reasonableness of the regulatory estimate (and the individual parameter estimates that led to it). In particular, there must be questions about whether such an allowed return on equity is commensurate with prevailing conditions in the market for funds and whether it provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

18. The currently available dividend yield for comparable firms is approximately 9%.[1] I add to this a conservative estimate of future capital gains of 2.5% - 3.5%. This suggests that share prices

[1] Set out in Table 5 in the body of this report.

experience real growth of 0% – 1%, and so is quite conservative.[2] This produces a forecasted return on equity of 11.5% - 12.5% for the set of comparable firms.

19. The allowed return on equity based on an equity beta estimate of 0.8 provides equity holders in the benchmark firm with a return of 9.3% from dividends and capital gains.[3] This can be compared with a return from dividends and capital gains, from comparable firms, of 11.5% to 12.5%.

20. If the allowed return is materially less than the return that investors might reasonably expect to receive from an investment in comparable firms, there must be questions about the reasonableness of the regulatory estimate (and the individual parameter estimates that led to it). In particular, there must be questions about whether such an allowed return on equity is commensurate with prevailing conditions in the market for funds and whether it provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

Reasonable range for equity beta

Range for benchmark efficient gas transmission and distribution business

21. My conclusions are as follows:

    a. The starting point, and previously adopted, equity beta estimate is 1.0;

    b. One would only move from this starting point value to the extent that:

        i. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 was warranted; and

        ii. The resulting equity beta value resulted in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

    c. The current regulatory estimate of equity beta is 0.8, however that estimate:

        i. Is statistically unreliable and that proper analysis of the available data does not warrant a move away from the starting point of 1.0; and

        ii. Produces an estimate of the required return on equity that is not commensurate with prevailing conditions in the market for funds and does not provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

    d. Having determined that an equity beta of 0.8 *does not* produce an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and which provides the service provider with a reasonable opportunity to recover at least

[2] The AER's Envestra Draft Decision also uses this conservative estimate of share price growth in its calculations of "the most appropriate return on equity that can be derived from analyst reports." Envestra Draft Decision, p. 260. In this regard, I also note that equity analysts are forecasting an increase in distributions for the comparable firms and are almost exclusively recommending that investors buy or hold these firms. There is no evidence of any forecast of declining distributions or stock prices.

[3] For example, using the parameter estimates in the AER's Amadeus Pipeline Final Decision.

the efficient cost of capital, the task is to find an estimate of equity beta that *does*. In this regard, I conclude that the starting point and previously adopted estimate of 1.0 does produce an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and does provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

22. In my view, an equity beta estimate of 1.0 (together with an MRP estimate of 7%) produces an estimate of the required return on equity that is broadly consistent with the prevailing conditions in the market for funds, and a beta estimate of 0.8 (together with an MRP estimate of 6%) does not. Equity beta estimates below 0.8 (and given MRP estimates of 6% or 6.5%) produce estimates of the required return on equity that are so inconsistent with evidence about the prevailing conditions in the market for funds that they should not be given any consideration.

1. Context for report

23. The regulatory estimate of the required return on equity, r_e, is an estimate of the expected return that is required by potential equity investors before they will commit the required amount of equity funding to the benchmark regulated firm.

24. The National Gas Rule (**Rules**) 87(1) require that:

> The rate of return on capital is to be commensurate with prevailing conditions in the market for funds and the risk involved in providing the Reference Service.[4]

25. In this report, I consider the types of tests, checks and comparisons that one would apply to determine whether a proposed rate of return on capital is commensurate with prevailing conditions in the market for funds. For example, it is my view that one such check would be to compare the proposed return with the return that investors might reasonably expect from an investment in a comparable firm. In my view, a proposed return that is materially different from the return that investors might reasonably expect from a comparable firm could not be said to be commensurate with prevailing conditions in the market for funds.

26. Moreover, Section 24(2)(a) of the National Gas Law (**Law**) provides that:

> A service provider should be provided with a reasonable opportunity to recover at least the efficient costs the service provider incurs in providing reference services.

27. In this report, I also consider the types of tests, checks and comparisons that one would apply to determine whether a proposed rate of return provides a service provider with a reasonable opportunity to recover at least their efficient costs (specifically, their cost of capital). In my view, for example, a proposed return on equity that is materially below the return on equity that investors might reasonably expect from a comparable firm could not be said to provide the service provider with a reasonable opportunity to recover at least the efficient cost of equity.

28. Rule 87(2) provides that:

> In determining a rate of return on capital:
>
> (a) it will be assumed that the service provider:
> (i) meets benchmark levels of efficiency; and
> (ii) uses a financing structure that meets benchmark standards as to gearing and other financial parameters for a going concern and reflects in other respects best practice; and
>
> (b) a well accepted approach that incorporates the cost of equity and debt, such as the Weighted Average Cost of Capital, is to be used; and a well accepted financial model, such as the Capital Asset Pricing Model, is to be used.[5]

[4] National Gas Rules Version 2, Rule 87 (1)
[5] National Gas Rules Version 2, Rule 87 (2)

29. Rule 87(2) addresses the mechanism by which the allowed return might be estimated. It requires the use of a well-accepted approach such as the CAPM-WACC framework. However, the use of a particular modelling framework does not guarantee an outcome that is consistent with the requirements of Rule 87(1). In my view, one would still need to apply a number of tests, checks and comparisons to determine whether a proposed rate of return on capital is commensurate with prevailing conditions in the market for funds and provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital. The use of a particular estimation or modelling framework does not guarantee that the resulting output is an allowed return that is commensurate with prevailing conditions in the market for funds or that it provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

30. In this report I have proceeded on the basis that if one concluded that a particular proposed estimate of equity beta *does not* produce an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and which provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital, the task would be to find an estimate of equity beta that *does*.

2. Role of equity beta

Equity beta is a function of business activities and leverage

31. Under the CAPM, the required return on a firm with an average level of systematic risk is equal to the risk-free rate plus the market risk premium. That is, investors require a base return of the risk-free rate plus compensation for bearing systematic risk. If a particular company has half the systematic risk of the average firm, its investors will only require half as much compensation for bearing systematic risk. Conversely, if a particular company has twice the systematic risk of the average firm, its investors will require twice as much compensation for bearing systematic risk. Equity beta is a measure of the systematic risk of a particular firm relative to that of the average firm.

32. There are two things that determine the relative systematic risk, or equity beta, of a particular firm:

    a. The type of business that the firm operates; and

    b. The amount of financial leverage employed by the firm.

33. This was explicitly recognised by the AER in its Review of WACC Parameters where the *Explanatory Statement* correctly notes that a firm's systematic risk (its equity beta) depends:

> on its business activities and its level of financial leverage.[6]

34. In relation to business activities, firms that operate in industries that tend to generate stable cash flows that are largely uncorrelated with changes in aggregate wealth (proxied by the returns on a broad stock market portfolio) tend to have lower betas, other things equal.

35. Financial leverage refers to the relative amounts of debt and equity financing used by a firm. Other things equal, firms with relatively more debt tend to have higher equity betas. This is because the introduction of prior-ranking debt results in greater variation in the residual cash flows to equity.

36. These two effects can be disaggregated using a process known as "un-levering." For example, the approach that the AER uses to disaggregate equity beta into its two components is:

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

where β_a is the asset beta, which reflects the systematic risk of the business activities of the benchmark firm but not the effect of leverage, and D/E reflects the relative amounts of debt and equity financing.

[6] AER *Review of WACC Parameters: Explanatory Statement*, p.181.

The two components of equity beta act in opposite directions for gas businesses

37. It is generally accepted that the business activities of regulated gas distribution and transmission businesses have less systematic risk than average. But it is also clear that such businesses have much higher financial leverage than the average firm. It has become standard to assume 60% debt financing for a regulated network distribution or transmission business, whereas the average firm has 30% debt financing.[7] That is, the two effects operate in different directions for regulated gas distribution and transmission businesses:

    a. Their business activities would suggest lower than average systematic risk; but

    b. Their financial leverage would suggest higher than average financial risk.

38. There is no compelling *a priori* reason to suggest which of these effects should dominate the other. To see this, first note that the asset beta (according to the definition adopted by the AER) for the average firm is 0.7:

$$\beta_e = \beta_a\left(1+\frac{D}{E}\right)$$
$$1.0 = 0.7\left(1+\frac{30}{70}\right)$$

and that an asset beta of 0.4 would imply an equity beta of 1.0 for a gas distribution or transmission business with leverage of 60%:

$$\beta_e = \beta_a\left(1+\frac{D}{E}\right)$$
$$1.0 = 0.4\left(1+\frac{60}{40}\right).$$

39. That is, setting the equity beta for a gas distribution or transmission business to 1.0 is consistent with the business activities of such businesses having only 57% of the systematic risk of the average business (0.4/0.7). Whereas it is generally agreed that the business activities of gas distribution or transmission businesses have less systematic risk than those of the average firm, there is no consensus about the quantum of that risk differential. For example, it is certainly not clear *a priori* that the business activities of gas distribution or transmission businesses would be expected to have only half the systematic risk of the business activities of the average firm. That is, to have an *a priori* expectation that gas distribution or transmission businesses have an equity beta less than 1.0 requires a corresponding *a priori* expectation (using the re-levering formula adopted by the AER) that the business activities of such firms have less than 57% of the systematic risk of the business activities of the average firm.

A priori expectations of equity beta for gas businesses

40. In my view, the appropriate *a priori* expectation (or starting point) is that the equity beta for gas distribution or transmission businesses is no different from that of the average firm, which is 1.0. The lower than average systematic risk of business activities acts to reduce equity beta, but the

[7] See, for example, ACG (2008) p. 6.

higher than average leverage tends to increase it, and there is no clear *a priori* reason why one of these effects would be expected to outweigh the other.

41. One would only move from the starting point estimate of 1.0 to the extent that:

    a. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 was warranted; and

    b. The resulting equity beta value resulted in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover the efficient cost of capital.

42. In summary there are a number of reasons why 1.0 is an appropriate starting point:

    a. The mean equity beta across all firms is 1.0;

    b. There are two components of equity beta. For gas distribution and transmission firms, one of these components suggests lower than average systematic risk and the other suggests higher than average systematic risk;

    c. The regulatory precedent prior to the AER's Review of WACC Parameter Estimates was to set equity beta to 1.0 for gas and electricity transmission and distribution firms. The AER subsequently concluded that a lower value of equity beta would be appropriate, based on an empirical analysis of the available data. However, as set out below, there are reasons to conclude that the results of that analysis are unreliable. If this is the case, that analysis should not be relied upon for departing from the previously adopted value of 1.0.

3. Recent regulatory estimates

Overview

43. An equity beta estimate of 0.8, based on leverage of 60%, has been used in a number of recent regulatory determinations for gas distribution and transmission businesses. This estimate emanates entirely from the AER's Review of WACC Parameter Estimates and the resulting Statement of Regulatory Intent (**SoRI**).

44. In this section, I examine the reliability and robustness of the SoRI estimate of 0.8. I conclude that this estimate is unreliable for a number of reasons including:

    a. The data set on which it is based is so small and incomplete that no econometric technique applied to it (no matter how carefully applied) can produce estimates that are precise and reliable;

    b. The individual estimates on which the AER's estimate is based are, in many cases, implausible;

    c. The individual estimates on which the AER's estimate is based are inconsistent between firms and over time;

    d. The AER's estimate ignores important information about the precision of beta estimates (i.e., the AER does not consider standard errors, which is inconsistent with standard statistical and econometric practice);

    e. The AER's estimate ignores important information about the reliability and informativeness of beta estimates (i.e., the AER does not consider R^2 statistics, which is inconsistent with standard statistical and econometric practice);

    f. The AER's estimate ignores the issue of bias in beta estimates, which is inconsistent with standard statistical and econometric practice and with the practice of commercial beta services.

Present regulatory estimate of equity beta is 0.8

Basis of current regulatory estimates

45. In three recent final decisions in relation to gas distribution and transmission businesses, the AER has re-affirmed the equity beta estimate of 0.8 adopted in the SoRI:

> Consistent with the 2009 WACC review, the AER's draft decision considered that an equity beta of 0.8 would ensure that the service provider has the opportunity to recover at least its efficient costs incurred in providing reference services.[8]

[8] Amadeus Final Decision, p. 67; QLD Final Decision, p. 42; SA Final Decision, p. 47. In the Amadeus Final Decision, the AER notes that "while the SoRI has no status under the NGR, it was intended to provide guidance to the gas sector."

> The AER maintains its position in the draft decision and considers that an equity beta of 0.8 provides the best estimate commensurate with prevailing conditions in the market for funds and the risks involved in providing reference services, as required under r. 74(2) and r. 87(1) of the NGR.[9]

46. In the recent final decisions, the AER sets out two reasons for adopting an equity beta estimate of 0.8. The first of these reasons is as follows:

> The AER considers that, on both theoretical and empirical grounds, the lower systematic risk faced by regulated businesses more than offsets the impact of higher financial risk faced by these businesses. This is supported by the AER's empirical estimate of an equity beta range of 0.4 to 0.7 for regulated energy businesses, which is less than the market equity beta of 1.0. The AER's approach to estimating equity betas addresses the impact of both types of risk. It takes a sample of firms with a similar level of systematic risk, and then adjusting the sample for financial risk to reflect the target benchmark gearing level.[10]

47. That is, the AER's first reason for adopting an equity beta of 0.8 is that it is "supported by the AER's empirical estimate of an equity beta range." These empirical estimates were conducted as part of the 2009 Review of WACC Parameters and published in the SoRI. The AER has not performed any new empirical analysis since the SoRI.

48. The AER's second reason for adopting an equity beta of 0.8 is that:

> The AER considers that regulated businesses face lower systematic risk than the market, primarily due to the stable cash flows of these businesses. The lower equity beta is the result of a regulatory regime that provides protection to regulated businesses that are not available to those in the competitive environment.[11]

49. The AER then goes on to list reasons why the business operations of a gas distribution or transmission business might be thought to have lower systematic risk than the business operations of the average firm. But this is already generally accepted. The real question is one of quantum not direction – the extent to which the higher leverage of gas distribution or transmission firms offsets the lower risk of business operations. And the only evidence to support the AER's conclusion that "the lower systematic risk faced by regulated businesses more than offsets the impact of higher financial risk faced by these businesses" is the empirical estimates produced as part of the SoRI process in 2009 – as set out in Paragraph 46 above.

50. Consequently, the current estimate of 0.8 is based only on the empirical evidence produced as part of the SoRI process.

Implications of current regulatory estimates

51. The present regulatory estimate of 0.8, based on leverage of 60%, implies an asset beta of 0.32:

[9] Amadeus Final Decision, p. 68; QLD Final Decision, p. 42; SA Final Decision, p. 47.
[10] Amadeus Final Decision, p. 68.
[11] Amadeus Final Decision, p. 68.

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

$$0.8 = 0.32\left(1+\frac{60}{40}\right).$$

52. That is, the regulatory estimate of 0.8 implies that the business operations of a gas distribution or transmission firm have *less than half* the risk of those of the average firm.[12]

53. As set out above, it is generally accepted that the business operations of gas distribution or transmission businesses have less systematic risk than the average firm. The key question concerns the quantum. An equity beta estimate of 0.8 implies a very wide gap between the systematic risk of the business activities of gas distribution and transmission businesses and those of the average firm. There is no *a priori* reason to believe that the business operations of a gas distribution or transmission firm have *less than half* the risk of those of the average firm.

The origins of the regulatory estimate of 0.8

54. As part of its Review of WACC parameter estimates, the AER commissioned a consultant report in relation to the empirical estimation of equity betas from the available data. The empirical evidence on which the AER's 0.8 estimate is based is set out in that report, Henry (2008). In this sub-section, I summarise the empirical analysis that was performed by Henry (2008) and how the AER evaluated and interpreted that evidence.

55. Henry (2008) and the AER consider beta estimates for a set of Australian firms and for a set of international firms. It is clear that the AER considers the estimates in relation to the Australian firms to be most relevant and the international firms to provide only a cross check. Specifically:

> …the AER will be exercising extreme caution when examining foreign beta estimates for the purposes of setting a benchmark efficient equity beta…The AER considers that it may be appropriate to use the point estimates of foreign equity betas as a cross check.[13]

56. In relation to beta estimates for Australian firms, the AER was specific in the instructions given to its consultant in terms of the time period to be examined. Henry (2008) notes that:

> The consultant was instructed by the ACCC [sic] to examine data over the period January 1st 2002 to 1st September 2008.[14]

57. Henry (2008) examines a total of ten firms. Four of these firms are ultimately excluded from the analysis due to concerns that they are not representative:

[12] The asset beta of the average firm is 0.7 and the regulatory estimate implies an asset beta of 0.32 for the gas distribution or transmission business.

[13] *Explanatory Statement*, p.197.

[14] Henry (2008, p.4). Note that Henry (2008, p.6) does mention estimates for two firms based on longer time periods, but these periods include the tech bubble and use a price index instead of the universally adopted accumulation index as the proxy for the market return, and should therefore be ignored.

> Given the concerns about the impact of takeover activity and the quality of the data available for AAN and GAS expressed in section 5.1 below, we exclude these stocks from our portfolio analysis. Moreover, data on these stocks is not available for the full sample period January 1st 2002 – September 1st 2008 as both stocks were delisted prior to the end of the sample. Similarly, AGKX was excluded because of concerns about the impact of corporate restructuring on the price data. Finally, given that the focus of ORGX is retail rather generation [sic] we do not consider this stock.[15]

58. This leaves only six firms. Of these six firms, only two had data available for the (relatively short) period specified by the AER.[16]

59. The most standard approach for estimating equity betas uses returns sampled at the monthly frequency. However, the paucity of the data that is available is clearly a concern for the AER's consultant, who concludes that:

> Given the short sample available for firms such as DUEX, HDFX, SPAU and particularly SKIX, the use of monthly data is unlikely to produce statistically valid inference.[17]

60. Due to these problems with the availability of data, Henry (2008) uses returns sampled at the (non-standard) weekly frequency. It appears that Henry uses weekly returns due to the fact that the more standard monthly returns would produce such a small number of observations that nothing of any use could be derived from it. He refers to the weekly returns as nothing more than a "best compromise" in the circumstances.[18]

61. In the remainder of this section, I set out a number of reasons why the empirical analysis on which the regulatory estimate of 0.8 is based is statistically unreliable and commercially implausible.

Lack of relevant data

62. The sample of data that forms the basis of the AER's empirical estimates of beta consists of returns for only six firms, none of which is a pure play gas distribution or transmission business, and for only two of which is data available for the (short) period specified by the AER.

63. In my view, the scant and incomplete data set that is relied upon by the AER is not sufficient to produce beta estimates that are robust or reliable.

64. In this regard, I note the view of the AER that:

> The AER considers that a sample of four firms is unlikely to provide a robust equity beta estimate.[19]

[15] Henry (2008, p. 8).
[16] Henry (2008, p. 5).
[17] Henry (2008, p. 5). As a result, Henry uses returns sampled at the weekly frequency. I discuss this further below.
[18] Henry (2008, p.20).
[19] *Explanatory Statement*, p. 195.

and that the data set on which the AER's estimates are based consists of four firms or less for the majority of the sample period.

65. The problem is that there is simply not enough data. That problem cannot be remedied by measuring returns in different ways or applying variations to the estimation methodology. If there is not enough food to feed a family, slicing or dicing it in different ways will not help. Henry (2008) has analysed the data set in accordance with his instructions – but the available data set is so small and incomplete that nothing can be done with it to produce reliable results. No econometric technique applied to the Henry data set (no matter how carefully applied) will produce estimates that are precise and reliable. It is not surprising that, as set out below, the analysis of this data set produces results that are implausible.

Individual estimates are implausible and inconsistent at face value

66. The AER states that it supports the view that:

> reliability of the empirical estimates, availability of data (cross-sectional and across time), consistency of empirical estimates (over time, across businesses, across empirical methods)[20]

are all "key objective criteria" for estimating WACC parameters.

67. Table 1 of Henry (2008) sets out equity beta estimates based on returns measured in continuous and discrete form and based on the OLS and LAV regression methodologies.[21] All of the different combinations of return measures and empirical techniques are applied to the same limited data set. There are several features of the resulting estimates that point to their unreliability:

    a. Several of the estimates in the table are clearly implausible and could not possibly be taken seriously as estimates that one would use in the CAPM to estimate the required return on equity. For example, the estimated equity beta of 0.13 for Envestra implies an asset beta of 0.0375[22] in which case the firm would be able to finance *all* of its assets with equity by offering a return only 23 basis points above the risk-free rate; [23]

    b. There is also substantial variation in beta estimates across firms. The re-levered beta estimates for different firms reported by Henry (2008) (which are all supposed to be estimates of the same thing) range from less than 0.3 to more than 1.0.[24]

    c. There is also substantial variation in beta estimates across empirical methods, including different estimation techniques (OLS, LAD, etc.) and different sampling frequencies (weekly, monthly, etc.). For example, Henry (2008) reports that some of the "comparable" firms have equity beta estimates that are more than five times the estimates for other firms. For some individual firms the estimate doubles or halves if a different variation of the empirical method is used. Indeed Henry (2008, p. 6) notes that "it is clear that the estimates themselves vary across estimator, which may suggest the presence of outliers or structural instability;"

[20] *Explanatory Statement*, p. 48.
[21] Henry (2008, p.5) and reproduced in the *Explanatory Statement*, p. 200.
[22] Using the approach adopted by the AER to convert between asset and equity betas.
[23] 0.0375 × 6% = 0.225%.
[24] Henry (2008), p.18.

d. The estimates that have been produced also vary substantially over time. For example, the recursive estimates computed by Henry (2008) show that it is quite common for equity beta *estimates* for the same firm to double or triple over the course of several months.[25] These figures also illustrate the tremendous width of the confidence intervals, which in almost every case contain the value of 1.0. That is, the data cannot reject the hypothesis that the equity beta is 1.0.

68. In summary, it is difficult to imagine any set of estimates faring worse on the AER's "key objective criteria." [26]

The AER's estimate ignores important information about the imprecision of the beta estimates: Standard errors

69. The precision of any empirical estimate is, in general, one of the relevant considerations to take into account when determining whether to afford material weight to that estimate. The precision of an estimate is quantified by the standard error of that estimate – other things equal, a more precise estimate has a lower standard error. The standard error can then be used to construct a confidence interval – a range that contains the true value of the parameter with a certain probability. It is standard statistical and econometric practice to report standard errors and to consider parameter estimates within the context of a statistical confidence interval.

70. The AER's *Explanatory Statement* discusses standard errors of beta estimates at some length and states among other things that:

> The width of the confidence interval is an indicator of the precision of the point estimate.[27]

I agree with this and consider it to be uncontroversial.

71. However, the AER ultimately concludes that it will not use standard errors and the resulting confidence intervals when determining the appropriate equity beta. The *Explanatory Statement* sets out the AER's rejection of confidence intervals in relation to estimates of equity beta:

> …it is likely that a forward-looking equity beta will be represented by a the [sic] point estimate of the equity beta rather than the upper and lower bounds.[28]

and that in relation to beta estimates:

> …the AER has had regard to the point estimates rather than the range of possible estimates within confidence intervals.[29]

72. It is my view that one cannot possibly determine the weight to apply to a particular empirical estimate without proper consideration of the statistical precision and reliability of that estimate.

[25] Henry (2008), Appendix 1 and 2.
[26] *Explanatory Statement*, p. 48.
[27] *Explanatory Statement*, p. 216.
[28] *Explanatory Statement*, p.219, error in original.
[29] *Explanatory Statement*, p.219.

73. In rejecting the use of standard errors, confidence intervals, and R^2 statistics (dealt with in the subsequent section) the AER has no basis at all for determining the precision or reliability of empirical beta estimates.

74. In the present regulatory environment there are two other specific reasons to employ standard errors and the associated confidence intervals:

    a. A confidence interval allows one to conclude whether a particular econometric method applied to a particular sample of data produces an estimate that is significantly different from a particular value. For example, if the starting point estimate of equity beta is set at 1.0 a confidence interval allows one to test whether or not a particular estimate is significantly different from 1.0. For this reason, it would seem that confidence intervals and standard errors would be relevant considerations; and

    b. It follows logically that higher regulatory beta estimates will (other things equal) result in higher regulatory returns and a commensurately higher probability that the regulatory return will be sufficient for network service providers to recover at least the efficient cost of capital employed. If the probability of the regulated return being sufficient to recover at least the efficient cost of capital is a relevant consideration, some way of estimating this probability is required. This is exactly what the standard error and confidence interval is designed to do.

The AER's estimate ignores important information about the reliability of the beta estimates: R^2 statistics

Estimates are statistically unreliable when the R^2 statistic is low

75. When performing the sort of regression analysis that is used in beta estimation, it is standard practice to report an R^2 statistic. This statistic determines the degree to which the data is informative about the relationship that is being measured. An R^2 statistic close to 1.0 indicates that the data is highly informative, whereas a value close to 0 indicates that the data is uninformative about the relationship that is to be measured.

76. In the context of beta regression analysis, the AER agrees that:

> A low R-squared indicates that more of the variation in the variables is noise that is unrelated to the effect that is being measured, making it more difficult to obtain statistically reliable estimates.[30]

77. That is, the AER notes that the R^2 statistic is directly informative about the statistical reliability of empirical beta estimates, which in turn is a key consideration when determining the weight to be afforded to those estimates. It is standard practice to report the R^2 statistic with any regression results – consistent with the relevance and informativeness of that statistic

78. The *Explanatory Statement* and the AER's consultant report[31] do not report, consider, or give weight to any R^2 statistics. Consequently, the AER estimate of 0.8 was arrived at without any consideration of this important information.

[30] *Explanatory Statement*, p. 215.
[31] Henry, O.T. (2008), *Econometric advice and beta estimation*, November 28.

*R^2 statistics **are** low for relevant firms*

79. In a supplementary report, the AER's consultant sets out R^2 statistics for the analysis that formed the basis of the AER's equity beta estimate of 0.8. Table 1 below sets out those R^2 statistics, as reported by Henry (2009). These R^2 statistics are uniformly very low meaning that the available data is relatively uninformative in identifying the relationship between stock and market returns that the beta regression is seeking to measure. Indeed for only three of the estimates in the table below is the R^2 statistic above 15% and all of those cases are based on an incomplete sample of data, with the highest R^2 statistic in the table being based on only 18 observations. The AER itself has recognised that in these conditions it is "difficult to obtain statistically reliable estimates." [32] In my view, this itself is highly relevant in determining how much weight to apply to those estimates – if an estimate is obtained in circumstances in which it is "difficult to obtain reliable estimates," one should be very cautious about affording any material weight to that estimate.

Table 1. R^2 statistics of regression analysis using Australian data

Company	R^2 Monthly	R^2 Weekly
AGK	0.0415	0.0670
ENV	0.1025	0.0623
APA	0.1208	0.1189
GAS	0.0196	0.0477
DUE	0.1994	0.1166
HDF	0.158	0.1485
SPA	0.1362	0.0350
SKI	0.4924	0.0819
AAN	0.0764	0.0802

Source: Henry (2009).

Mis-estimation is a material issue when R^2 statistics is low

80. To quantify how unreliable beta estimates with low R^2 statistics might be, I have previously performed a Monte Carlo simulation analysis. I generated stock and market return data in a setting where the true equity beta is 1.00 (the signal) and where there is random variation in the data (the noise) commensurate with what is observed in practice. I then used the standard regression technique to obtain a beta estimate, which will differ from the true value (of 1.00) due to the noise in the data. I then repeated this procedure one million times.

81. My results show that where the true beta is 1.00 and the noise in the data is such that the R^2 statistic is very low, the standard regression approach is likely to produce beta estimates that are substantially below the true value of 1.00. That is, the noise in the data, which manifests itself in a low R^2 value, results in beta estimates being downwardly biased. It is most likely that one will obtain beta *estimates* that are lower than the true value, and even lower than the AER's estimate of 0.8, even when the true value is 1.0 – if the noise in the data is such that the R^2 statistic is low.

82. Henry (2009) replicates this analysis and confirms my result. He then argues that the results of my simulation analysis might not be generalizable for two reasons:

    a. The results are attenuated if the sample size is increased; and

[32] *Explanatory Statement*, p. 215.

b. I simulated data for a range of R^2 values (drawn from a simple uniform distribution) rather than using a different sort of distribution or tying back to market data.

83. In relation to sample size, Henry repeats the experiment after increasing the sample size to 208 (commensurate with the number of observations that would be available if weekly observations were taken over four years). However, he makes no adjustment for the fact that the distribution of weekly returns is obviously very different from the distribution of monthly returns. That is, he uses a sample size commensurate with weekly data and other parameters commensurate with monthly data.

84. To show that my results are robust to both issues raised by Henry (2009), I have re-performed the simulation analysis as follows:

a. First I computed monthly and weekly total stock returns on the stock index from 1 January 2002 to 31 August 2011, using end of month and end of week closing prices. The sample of market returns comprises 115 monthly returns with mean 0.56% and standard deviation 3.98%, and 503 weekly returns with mean 0.13% and standard deviation 2.26%.

b. I then sampled with replacement from these two empirical distributions, sampling 60 monthly returns and 261 weekly returns, respectively. I performed 6,000 samples of monthly returns and 1,000 samples of weekly returns. A smaller number of weekly returns samples was required for mean results to converge towards expected values. *That is, I make no assumption about the distribution of market returns – I draw actual observed market returns from the empirical distribution.*

c. I then simulated individual company stock returns so as to obtain a mean R^2 value of 20%, that figure being a representative R^2 value across all listed firms reported in the latest set of beta estimates from commercial data service provider CRIF. In particular, I simulated stock returns as:

$$r_i = 1.0 r_m + \varepsilon,$$

where $r_i \sim N(0, \sigma_\varepsilon)$ and σ_ε is determined so that $R^2 = 1 - \dfrac{\sigma_e^2}{\sigma_e^2 + \sigma_m^2} = 0.20$.

d. That is, the "true" beta and R^2 value for each regression is 1.0 and 20% respectively. I then use ordinary least squares regression to estimate beta and R^2 for each simulated sample. Of course the beta estimate and R^2 statistic for a particular simulated sample will differ from the "true" values due to random sampling error. The purpose is to determine whether there is a relationship between the beta estimate and the R^2 statistic – in particular, whether a low R^2 statistic is associated with a downwardly biased beta estimate.

85. The results of this analysis are set out in
86. Table 2 below, which shows a clear relationship between the R^2 statistic and the beta estimate. In particular, when R^2 statistics are as low as those reported by Henry (2009) in Table 1 above, beta estimates can be (and indeed are likely to be) as low as those reported by Henry (2008) even when the true beta is 1.0. In my view, this implies the R^2 statistic should at least be considered when interpreting empirical beta estimates. However, the AER's estimate of 0.8 was reached without any consideration of the very low R^2 statistics whatsoever.

Table 2. Relationship between R^2 statistics and beta estimates

	Mean beta estimates	
R^2 statistic (%)	Monthly data (60 observations)	Weekly data (261 observations)
3-7	0.50	0.58
8-12	0.69	0.72
13-17	0.85	0.87
18-22	0.99	1.00

Source: SFG calculations.

Mis-estimation is a material issue when R^2 statistic is low

87. The AER has stated that in circumstances where the R^2 statistic is low it is "more difficult to obtain statistically reliable estimates."[33] This is an important consideration that goes to the weight that should properly be afforded to the empirical estimates. However the AER does not consider (or even report) any R^2 statistics, which is inconsistent with standard statistical and econometric practice.

The AER's estimate makes no adjustment to correct for the demonstrated bias in beta estimates

88. Beta estimates derived from an OLS regression of stock returns against market returns are known to be systematically biased in that low estimates have a high probability of understating the true risk of the stock. This statistical bias exists even though "noise" or "random error" in the data is perfectly symmetric – being equally likely to increase or decrease stock prices.

89. To see why this is the case, consider the following example:

> Suppose that every firm is known to have a *true beta* of 1, but when we run regressions there is estimation error, so the regression *estimates* can be above 1 or below 1. Those estimates that are below 1 are known to have negative estimation error (as that is the only way the estimate could have been below 1 in this setting) and those that are above one are known to have positive estimation error. That is, by observing the beta estimate, we can infer something about how it has been affected by estimation error.

[33] *Explanatory Statement*, p.215.

> Now suppose that all firms have a beta of either 0.8, 1.0 or 1.2, with one third of stocks in each group. But we don't know which is which, so we have to rely on our beta *estimates*. Also suppose that every time we estimate beta there is a one-third chance that we recover the true value or that our estimate is over- or under-estimated by 0.2. That is, there is a range of true betas (0.8 or 1.0 or 1.2), and estimation error for any individual beta estimate is perfectly symmetric (-0.2 or 0 or +0.2). Now suppose you *estimate* a particular firm to have a beta of 0.8. There are two possibilities here (a) the true beta is 0.8 and the estimation error was 0; or (b) the true beta is 1.0 and the estimation error was -0.2. Within this setting, these are the only two ways of obtaining a beta estimate of 0.8. In this case, we know from observing the beta estimate of 0.8 that it has either zero or negative estimation error – this is a negative bias. To correct this bias we would adjust the estimate towards 1.0. In this case, our statistical estimate of 0.8 tells us that there is a 50/50 chance that the true beta is either 0.8 (and estimation error is 0) or 1.0 (and estimation error is -0.2). Consequently, the best unbiased estimate would be 0.9 as this is an estimate that is equally likely to be above or below the true value. That is, our best expectation of the true beta is 0.9 even though the beta estimate is 0.8 and estimation error is symmetric.
>
> But does this negative bias disappear when we introduce the possibility that some stocks might have a true beta of 0.6, so that our estimate of 0.8 has been contaminated by *positive* estimation error? No – imagine betas being normally distributed around 1.0. There are more firms with a beta close to 1.0 than with beta far from 1.0. So there will always be more chance that a beta estimate of 0.8 will be from a true beta of 1.0 with negative estimation error than from a true beta of 0.6 with positive estimation error. Moreover the further our beta estimate is below 1.0, the more likely it is to have been affected by negative estimation error.

90. That is, all equity beta estimates that are less than 1.0 are downwardly biased – when we obtain a beta estimate that is less than 1.0 we know that it is more likely to have been affected by negative estimation error than by positive estimation error. Consequently, our best estimate of the true value of beta is *higher* than the estimated value. This effect is well-known in the relevant literature[34] and the use of methods to adjust for this bias is commonplace among commercial providers of beta estimates.

91. The materiality of the statistical bias in beta estimates can be illustrated by the following simulation. Suppose that the true betas for all stocks in the market are normally distributed with a mean of one and a standard deviation of 0.5. This means that 68% of stocks have betas within the range of 0.5 – 1.5 and 95% of stocks have betas within the range of 0.0 – 2.0.[35] Also suppose that estimation errors are normally distributed with mean zero and standard deviation of 0.8. That is, any individual beta estimate is equally likely to have been affected by positive or negative estimation error. This implies that beta estimates are normally distributed with a mean estimate equal to their true beta and standard deviation of 0.8.

92. I have used Monte Carlo simulation to generate a sample of one million true betas and beta estimates in accordance with the values set out above. I then form deciles based on the simulated

[34] See, for example, Vasicek (1973).

[35] This just comes from the standard statistical properties of a normal distribution – 68% of observations are within one standard deviation of the mean and 95% are within two.

beta estimates. For each decile I report the mean beta estimate and the mean true beta in Table 3 below.

Table 3. Simulation results illustrating the bias in beta estimates

Decile	Mean actual beta	Mean beta estimate	Prob Estimate > Actual Beta (%)
(1)	(2)	(3)	(4)
1	0.53	−0.66	1
2	0.72	0.02	5
3	0.82	0.36	14
4	0.90	0.64	27
5	0.97	0.88	42
6	1.03	1.12	58
7	1.10	1.37	73
8	1.18	1.64	86
9	1.28	1.99	95
10	1.46	2.66	99

93. In Table 3, the average *true* beta for the firms in each decile is reported in Column (2) and the average beta *estimate* is reported in Column (3). What the results show is that in *all* cases where the estimate is less than 1.0 it is downwardly biased (less than the true value) – consistent with the conceptual argument above. For example, in Decile 4 for the average firm the beta estimate is 0.64 whereas the true value is 0.90. Of course, the reverse is true for estimates above 1.0.

94. The AER's beta estimate of 0.8 is based on a range of estimates that are less than 1.0. All beta estimates that are less than 1.0 are downwardly biased. The simulation analysis in Table 3 shows that the degree of bias can be material. Yet the AER's analysis does not recognise the existence of bias and does nothing to quantify or correct for that bias in the estimates of equity beta – even though the existence of bias is well-recognised in the relevant literature and bias correction methods are commonplace among commercial data service providers.

Conclusions

95. As set out above, the move from the starting point equity beta estimate of 1.0 to the revised estimate of 0.8 should only be made if:

    a. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 is warranted; and

    b. The resulting equity beta value results in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

96. In this section of the report I have addressed the first of two elements set out above and conclude that the statistical analysis on which the regulatory estimate of 0.8 is based is so unreliable that it should be afforded little weight. The reasons for this conclusion include:

    a. The data set on which it is based is so small and incomplete that no econometric technique applied to it (no matter how carefully applied) can produce estimates that are precise and reliable;

b. The individual estimates on which the AER's estimate is based are, in many cases, implausible;

c. The individual estimates on which the AER's estimate is based are inconsistent between firms and over time;

d. The AER's estimate ignores important information about the precision of beta estimates (i.e., the AER does not consider standard errors, which is inconsistent with standard statistical and econometric practice);

e. The AER's estimate ignores important information about the reliability and informativeness of beta estimates (i.e., the AER does not consider R^2 statistics, which is inconsistent with standard statistical and econometric practice);

f. The AER's estimate ignores the issue of bias in beta estimates, which is inconsistent with standard statistical and econometric practice and with the practice of commercial beta services.

4. The implications of the regulatory estimate of 0.8

Overview

97. In this section of the report, I consider whether an equity beta estimate of 0.8 produces an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

The approach on which the AER's estimate is based produces nonsensical outcomes in other industries

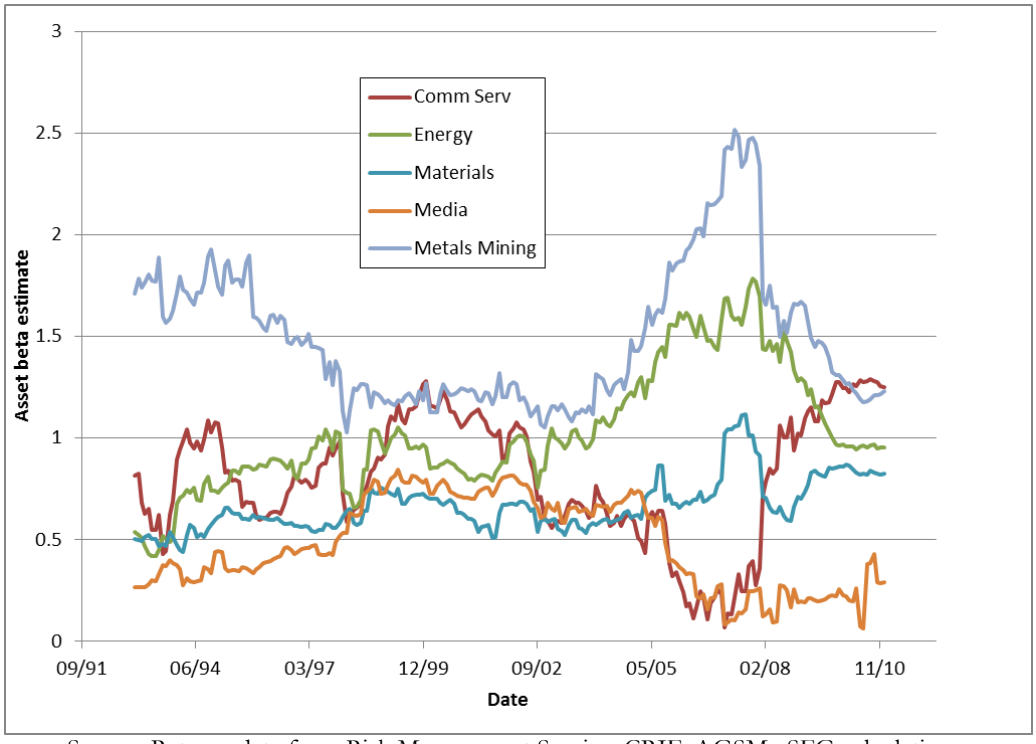
98. The AER beta estimate is based on data for a set of 4-6 comparable firms over a period of approximately five years. One test of the reliability of this approach would be to examine the characteristics of the beta estimates produced over a period of time. If that approach produced economically reasonable and relatively stable estimates over time, one would have more confidence in the veracity and reliability of the results. Conversely, if the approach produced beta estimates that varied wildly over time for no apparent reason, one would have much less confidence in them.

99. Unfortunately, we cannot examine the performance of the AER technique over time. Australian data only allows one such estimate – it is only in recent years that data has been available even for 4-6 firms. Prior to this recent period, there were only one or two relevant listed firms – making it impossible to examine the stability of estimates over a period of 20 years or more.

100. However, we can examine the historical performance of the AER technique as applied to other industries. To examine this, I sorted firms by the GICS industry classification scheme used by the ASX. Within each industry, I selected five comparable firms that had stock return and annual report data available from December 1988 to December 2010. I then follow the AER approach by estimating the equity beta for each firm using five years of returns data. I convert these estimates into asset betas using the same un-levering process adopted by the AER. I take the average asset beta over the five comparable firms and I repeat this every month over my sample period.[36] I show the results of this procedure in Figure 1 and provide some detail about the sample composition and variability in beta estimates in Table 4.

[36] There are several reasons why I plot the (unlevered) asset beta rather than a re-levered equity beta. First, the true asset beta is expected to be relatively constant over time – the true systematic risk of the business activities of a particular industry is expected to be stable with very little variation from quarter to quarter. By contrast, the true re-levered equity betas could vary from time to time if leverage was changing, so the interpretation of a comparable figure based on re-levered equity betas would be slightly more complex. Also, it is not clear what degree of leverage should be used in the re-levering calculation. For regulated businesses, the regulatory value of 60% debt is an obvious benchmark, but this is less clear for the case of unregulated commercial businesses.

Figure 1: Time series of asset betas from average of five comparables



Source: Returns data from Risk Management Service, CRIF, AGSM. SFG calculations.

Table 4: Summary of results for beta estimates using small sets of comparables

Quantity	Commercial Services	Energy	Materials	Media	Metals Mining
Firms included in sample	HMC	PSA	GNS	BYI	AMS
	ESI	BPT	ABC	STV	OXR
	ZEL	OSH	BKW	PRT	NCM
	CPB	ERA	HAH	SBC	RIO
	BIL	WPL	BOR	PBL	BHP
Mean asset beta over the period	0.80	1.03	0.67	0.48	1.50
Minimum asset beta over the period	0.07	0.42	0.44	0.06	1.03
Maximum asset beta over the period	1.29	1.79	1.12	0.85	2.52
Minimum (% below mean)	92%	59%	34%	87%	31%
Maximum (% above mean)	60%	74%	68%	78%	68%

101. Figure 1 and Table 4 show that the reliance on a small number of comparable firms produces asset beta estimates that vary wildly over time. By any measure, the variation in these beta estimates over time is extreme. The results of this approach suggest that:

a. the asset beta of the Metals and Mining industry has halved and then doubled and then halved again over the sample period;

b. the asset beta for the Energy sample has been below 0.5 and then above 1.5 at different times over the sample period;

c. the systematic risk of the Commercial Services industry halves and doubles on a regular basis, was all but eliminated for a period, and is now back above 1.0.

102. Moreover, even the ranking of beta estimates among industries is not stable using this approach. For example, the results above suggest that Commercial Services has the second greatest systematic risk during the early 1990s, was the least risky industry by 2006, and is now the most risky industry.

103. The conclusion from all of this is that the approach of taking the mean beta estimate from five comparable firms does not produce estimates of beta that are reliable, economically reasonable or are in any way commensurate with the market for funds.

Implied required return on equity materially lower than the return available from comparable firms

Use of current and forecasted dividend yields

104. An important consideration when determining whether a proposed regulatory return on equity, r_e, is consistent with prevailing conditions in the market is a comparison between that allowed regulatory return on equity and the return on equity that investors might reasonably expect to receive from comparable firms. If the allowed return is materially less than the return that investors might reasonably expect to receive from an investment in comparable firms, there must be questions about the reasonableness of the regulatory estimate (and the individual parameter estimates that led to it). In particular, there must be questions about whether such an allowed return on equity is commensurate with prevailing conditions in the market for funds and whether it provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

105. To determine the return on equity that investors might reasonably expect to earn from comparable firms, I begin by examining the dividend yield that is currently available from the set of firms that the AER has considered to be comparable to the benchmark firm. Table 5 below summarises the currently available dividend yield for the comparable firms.

Table 5. Currently available dividend yield for comparable firms

Comparable firm	Dividend yield (% p.a.)
APA	8.7
DUE	11.0
ENV	8.6
HDF	7.0
SKI	9.4
SPN	8.8
Average	8.92

Source: Morningstar, 26/09/2011.

106. Table 5 shows that if an investor was to buy shares in the average comparable firm, and if that firm was able only to maintain the current level of dividends with no growth whatsoever, the investor would receive a return of approximately 9% p.a. just from the maintenance of the current level of dividends.

107. It is theoretically possible that the current stock prices of the comparable firms reflect an expectation of decreases in dividends over time. To rule this out, Table 6 below summarises the

most recent dividend yield forecasts by firm and year from equity analyst research reports. Each cell contains the average dividend yield forecast across equity analysts in the sample.

Table 6. Average dividend yield by firm and year

	2012	2013	Average
APA	8.87	9.30	9.09
DUE	12.01	12.03	12.02
ENV	9.56	9.63	9.60
HDF	6.48	6.39	6.44
SKI	8.16	8.35	8.26
SPN	9.20	9.40	9.30
Average	9.05	9.18	9.12

Source: Various broker research reports.

108. Table 6 indicates that equity analysts forecast a continuation of the current dividend yield of approximately 9%, at least over the next two years.

109. I have also obtained consensus (average) analyst forecasts of distributions (expressed in cents per unit) compiled by Morningstar. These estimates are set out in Table 7 below, which indicates that distributions are expected to increase for all companies in the set of comparable firms. That is, investors who buy shares in the comparable firms today can reasonably expect to receive dividends over the coming year that will be sufficient to provide a yield of approximately 9%. The dividends that are expected to be paid in subsequent years are even higher, thereby providing a yield above 9% relative to today's stock price. In summary, this table establishes that the dividends that investors might reasonably expect to receive are sufficient to provide a yield of 9% or above, relative to the current stock price, for the foreseeable future.

Table 7. Consensus distribution payments by firm and year

	2012 (cents per unit)	2013 (cents per unit)	2014 (cents per unit)
APA	35.0	36.8	36.5
DUE	16.0	16.5	
ENV	5.8	5.9	6.1
HDF	10.4	12.0	
SKI	9.8	11.5	
SPN	8.0	8.1	8.4

Source: Morningstar, 26/09/2011

110. In summary, I conclude that the best currently available estimate of the dividend yield available on comparable firms is 9% p.a. and that there is no indication of an expected decline in dividends for any of the comparable firms.

Reasonable expectation of return on equity from comparable firms

111. If investors expect a dividend yield of 9% (on average) from comparable firms, and if the expected return in the form of capital gains is considered to be in the range of 2.5% to 3.5% p.a., this amounts to a combined return on equity in the range of 11.5% to 12.5% from comparable firms. I note that the 2.5% to 3.5% nominal capital gain is consistent with share prices just maintaining their real value, and was used by the AER in the Envestra Draft Decision as part of the AER's calculation of "the most appropriate return on equity that can be derived from analyst

reports." [37] Consequently, when determining whether a proposed allowed return on equity is commensurate with current conditions in the market for funds, one important consideration is the 11.5% to 12.5% return on equity that investors might reasonably expect to able to obtain on equity investments in comparable firms.

112. There is another theoretical possibility to rule out at this point. It is theoretically possible that current stock prices embed an expectation that prices will fall in the future. This can be ruled out by noting that the vast majority of equity analysts are currently recommending that investors hold their existing investments in the comparable firms or buy more, as set out in Table 8 below. This confirms that the assumption that prices will remain constant (in real terms) is a conservative one.

Table 8. Equity analyst recommendations for comparable firms

Comparable firm	Proportion of analysts recommending hold, buy, or strong buy
APA	100%
DUE	100%
ENV	80%
HDF	100%
SKI	75%
SPN	75%
Average	88%

Source: Morningstar, 26/09/2011.

Adjustment for assumed value of franking credits

113. When comparing the allowed regulatory return on equity with the return on equity that can reasonably be expected from comparable firms, it is important to ensure that the comparison is performed on a like-with-like basis. In particular, the 11.5% to 12.5% range consists of dividends and capital gains only, whereas the regulatory allowed return also includes an assumed value of franking credits. Specifically, the component of the regulatory return on equity that is due to dividends and capital gains only, using parameter estimates from the Amadeus Final Decision, is:

$$r_e \frac{1-T}{1-T(1-\gamma)} = 10.33\% \frac{1-0.3}{1-0.3(1-0.25)} = 9.3\%.$$

114. The derivation of this formula appears in Officer (1994) and it is consistent with the way that the assumed value of franking credits is used to adjust the return to equity holders under the National Electricity Rules, National Gas Rules and the AER's Post-tax Revenue Model.

Conclusions

115. The allowed return on equity in the Amadeus Final Decision provides equity holders in the benchmark firm with a return of 9.3% from dividends and capital gains. This can be compared with an allowed return from dividends and capital gains, from comparable firms, of 11.5% to 12.5%.

[37] Envestra Draft Decision, p. 260.

116. Logically, there are three possible reasons for such a divergence between the regulatory estimate of the return on equity and the return that investors might reasonably expect from comparable firms:

    a. The regulatory estimate is too low because the regulator has adopted estimates of beta or MRP (or both) that are too low; or

    b. The regulatory estimate is too low because the regulator has relied on the CAPM and even with the best possible input parameter estimates:

        i. The CAPM systematically under-estimates the required return for firms such as the benchmark firm, and/or

        ii. The CAPM under-estimates the required return for firms such as the benchmark firm in the current market circumstances; or

    c. My estimate of the return that investors would reasonably expect from comparable firms is too high.

117. That is, there is a divergence between the two estimates either because the regulatory estimate is too low, or because the market-based estimate is too high. There are a number of reasons to support the conclusion that the market-based estimate is not too high:

    a. My conclusions are based on current observed dividends. Investors will receive a return of 9%, on average, if the comparable firms are simply able to maintain the dividends that they currently pay, and there is no evidence to suggest that they will be unable to do this; and

    b. I have adopted a conservative estimate of future capital gains that the AER has recently adopted in its calculations of "the most appropriate return on equity that can be derived from analyst reports."[38]

118. Consequently, if the market-based estimate is not too high, the conclusion must be that the regulatory estimate is too low to be commensurate with current conditions in the market for funds. Specifically, if the regulatory estimate of equity beta (and/or MRP) is reduced and this results in an allowed return on equity that is materially below the return that would reasonably be expected from comparable firms, it follows that the reduction in the equity beta estimate (and/or MRP) has resulted in an allowed return on equity that is not commensurate with the prevailing conditions in the market for funds.

Conclusions

119. As set out above, the move from the starting point equity beta estimate of 1.0 to the revised estimate of 0.8 should only be made if:

    a. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 is warranted; and

    b. The resulting equity beta value results in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the

[38] Envestra Draft Decision, p. 260.

service provider with a reasonable opportunity to recover at least the efficient cost of capital.

120. In this section of the report I address the second of the two elements set out above and conclude that the regulatory estimate of 0.8 is not commensurate with prevailing conditions in the market for funds and does not provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital. The reasons for this conclusion include:

a. The regulatory estimate is based on the mean beta estimate from approximately five comparable firms. When this approach is applied to other industries, it produces estimates that vary so wildly over time that those estimates cannot possibly be considered to be a reliable reflection of systematic risk; and

b. The regulatory estimate of equity beta (with an MRP estimate of 6%) produces an allowed return on equity that is materially below the return that would reasonably be expected from comparable firms.

6. Conclusions and recommendations

Range for benchmark efficient gas transmission and distribution business

121. My conclusions are as follows:

a. The starting point, and previously adopted, equity beta estimate is 1.0;

b. One would only move from this starting point to the extent that:

i. Appropriate analysis of the available data suggested that a move away from the starting point of 1.0 was warranted; and

ii. The resulting equity beta value resulted in an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and that provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital.

c. The current regulatory estimate of equity beta is 0.8, however that estimate:

i. Is statistically unreliable to the extent that it is unable to properly support a move away from the starting point and previously adopted value of 1.0; and

ii. Produces (in conjunction with an MRP estimate of 6%) an estimate of the required return on equity that is not commensurate with prevailing conditions in the market for funds and does not provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital. That is, this estimate of the required return on equity would not be sufficient to attract the required amount of capital, given the prevailing conditions in the market.

d. Having determined that an equity beta of 0.8 *does not* produce an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and which provides the service provider with a reasonable opportunity to recover at least the efficient cost of capital, the task is to find an estimate of equity beta that *does*. In this regard, I conclude that the starting point and previously adopted estimate of 1.0 does produce an estimate of the required return on equity that is commensurate with prevailing conditions in the market for funds and does provide the service provider with a reasonable opportunity to recover at least the efficient cost of capital, as set out in Table 9 below. In particular, the table shows that:

i. When beta is set to 0.8 and MRP is set to 6% the allowed return on equity (ex franking credits) is materially lower than the return on equity (also ex franking credits) that investors might reasonably expect to receive from an investment in comparable firms; but that

ii. When the estimates of beta and MRP are set to 1.0 and 7% respectively the allowed return on equity (ex franking credits) is comparable to the return on equity (also ex franking credits) that investors might reasonably expect to receive from an investment in comparable firms

Table 9: Implications of different WACC parameter estimates

Parameter/Return	Amadeus Pipeline Final Decision [A]	Alternative estimate of MRP [B]	Alternative estimates of beta and MRP [C]
Risk free rate	5.53%	5.53%	5.53%
MRP	6%	7%	7%
Equity beta	0.8	0.8	1.0
Gamma	0.25	0.25	0.25
Allowed return on equity (ex franking credits)	9.3%	10.1%	11.3%
Return available from comparable firms (ex franking credits)	11.5-12.5%	11.5-12.5%	11.5-12.5%

122. In my view, an equity beta estimate of 1.0 and MRP estimate of 7% [Column C] produces an estimate of the required return on equity that is broadly consistent with the prevailing conditions in the market for funds, and a beta estimate of 0.8 and MRP estimate of 6% [Column A] does not.

123. Equity beta estimates below 0.8 (and given MRP estimates of 6% or 6.5%) produce estimates of the required return on equity that are so inconsistent with evidence about the prevailing conditions in the market for funds that they should not be given any consideration.

124. Finally, I note that when the equity beta is set to 0.8 and MRP is set to 7% [Column B] the allowed return on equity (ex franking credits) remains well below the return that investors could reasonably expect from comparable firms and is inconsistent with that allowed return being commensurate with the prevailing conditions in the market.

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Australian Energy Regulator (2011), "Final Decision: APT Allgas: Access arrangement proposal for the Qld gas network: 1 July 2011 – 30 June 2016," June, www.aer.gov.au.

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Appendix 1: Instructions

Professor Stephen Gray
Strategic Finance Group
SFG Consulting
Level 1, South Bank House
South Bank, QLD 4101

Email: s.gray@sfgconsulting.com.au

Dear Professor Gray

Roma to Brisbane Pipeline access arrangements 2012 – 2017: Measurement of the equity beta

Background

APT Petroleum Pipelines Ltd (**APTPPL**) owns the Roma to Brisbane Pipeline (**RBP**) which transports natural gas from the gas hub near Roma to the markets of Brisbane and the regional centres along the pipeline route. The mainline was constructed in 1969, is 438km long and runs from Roma (Wallumbilla) to Brisbane. The Peat lateral was constructed in 2001, is 121km long and runs from the Peat and Scotia gas fields to Arubial.

Pursuant to the National Gas Rules (**Rules**), APTPPL is required to submit an access arrangement revision proposal to the Australian Energy Regulator (**AER**) by 12 October 2011. The access arrangement revision proposal must, amongst other things, set out the amendments to the access arrangement that the service provider proposes for the following access arrangement period.

The reference service provided by the RBP is a non-interruptible service for the receipt, transportation and delivery of gas through any length of the pipeline in the direction from Wallumbilla or Peat to Brisbane.

Under the Rules, total revenue for a relevant service provider is determined for each regulatory year of the access arrangement using a "building blocks" methodology (rule 76). The building blocks include, amongst others, a return on the projected capital base for the year (subrule 76(a)).

Subrule 87(1) provides that the rate of return on capital is to be commensurate with prevailing conditions in the market for funds and the risks involved in providing reference services. Subrule 87(2) provides:

> "In determining a rate of return on capital:
>
> (a) it will be assumed that the service provider:
>
> (i) meets benchmark levels of efficiency; and
>
> (ii) uses a financing structure that meets benchmark standards as to gearing and other financial parameters for a going concern and reflects in other respects best practice; and
>
> (b) a well accepted approach that incorporates the cost of equity and debt, such as the Weighted Average Cost of Capital, is to be used; and a well accepted financial model, such as the Capital Asset Pricing Model, is to be used."

Subrule 72(1)(g) provides that the access arrangement information for a full access arrangement proposal must include the proposed rate of return, the assumptions on which the rate of return is calculated and a demonstration of how it is calculated.

Rule 74, which applies generally to forecasts and estimates (including those used in determining the return on capital), provides:

> "(1) Information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.
>
> (2) A forecast or estimate:
>
> (a) must be arrived at on a reasonable basis; and
>
> (b) must represent the best forecast or estimate possible in the circumstances."

Pursuant to section 28 of the National Gas Law (**Law**), in making a decision on whether to approve an access arrangement proposal, the AER must have regard to the National Gas Objective (in section 23 of the National Gas Law), which is:

> "…to promote efficient investment in, and efficient operation and use of, natural gas services for the long term interests of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas."

The AER must also take into account the revenue and pricing principles in section 24 of the Law when exercising a discretion in approving or making those parts of an access arrangement relating to a reference tariff. The AER may take into account the revenue and pricing principles when performing or exercising any other AER economic regulatory function or power (which is defined to include an applicable access arrangement decision), if the AER considers it appropriate to do so. The revenue and pricing principles in section 24 of the Law include the following:

> "(2) A service provider should be provided with a reasonable opportunity to recover at least the efficient costs the service provider incurs in—
>
> (a) providing reference services; and
>
> (b) complying with a regulatory obligation or requirement or making a regulatory payment.
>
> …
>
> (5) A reference tariff should allow for a return commensurate with the regulatory and commercial risks involved in providing the reference service to which that tariff relates.
>
> (6) Regard should be had to the economic costs and risks of the potential for under and over investment by a service provider in a pipeline with which the service provider provides pipeline services."

In its revised access arrangement proposal, APTPPL will be using a Weighted Average Cost of Capital (**WACC**) to determine its return on capital under rule 87(1) of the Rules. In this context, APTPPL is seeking the opinion of a recognised independent expert on the appropriate methodology and value to be adopted for the market risk premium component of the WACC. The approach to determining these parameters will be required to comply with the relevant provisions of the Rules and Law, including the Rules and Law set out above.

Scope of Work

You are briefed to provide an expert opinion report for use by APTPPL in its access arrangement revised proposal addressing the following questions:

Equity beta

1 In calculating APTPPL's return on capital, what do you consider to be the appropriate methodology to be adopted in estimating the equity beta, and what is the appropriate value to be adopted as an estimate of the equity beta? That is, what methodology and value should be adopted that will provide an equity beta that, when used in the WACC formula,

will result in a rate of return on capital that is commensurate with prevailing conditions in the market for funds and the risks involved in providing reference services. In answering these questions, please take into consideration:

(a) that the AER has previously indicated, particularly in its Statement of regulatory intent on the revised WACC parameters that applies to electricity distribution businesses and its Statement of the revised WACC parameters that applies to electricity transmission businesses, that it considers 0.8 is an appropriate estimate of the equity beta for these businesses, and the basis for that estimate;

(b) the methodology and data used to calculate the current regulatory estimate of 0.8 and any impact on the reliability, or otherwise, of the use of these methodology and data in estimating the equity beta;

(c) any data that could be used to improve the statistical reliability when estimating the equity beta;

(d) any statistical techniques that could be used to improve the reliability of estimates from the available data.

Information to be relied on

In providing your report, you are expected to draw upon the following information:

- the Law and the Rules in relation to the economic regulation of gas networks;
- the AER's Final "Electricity and Distribution Network Service Providers Statement of Revised WACC Parameters (transmission) Statement of regulatory intent on the revised WACC parameters (Distribution)" dated 1 May 2009, and the relevant materials generated by, and submitted to, the AER in the AER's WACC review;
- the AER's recent regulatory decisions, including its Final Decisions for the APT Allgas and Envestra gas distribution networks, and the Amadeus gas transmission network;
- published econometric, statistical, economic, financial and other relevant literature;
- relevant financial or economic data; and
- such information that, in your opinion, should be taken into account to address the questions outlined above.

Guidelines in preparing your report

The Guidelines for Expert Witness in the Federal Court of Australia are attached to this letter. Although this brief is not in the context of litigation, APT is seeking a rigorously prepared independent view for use in the context of regulatory decision making and you are requested to follow the Guidelines to the extent reasonably possible in this context.

In particular, within your report you are requested to:

(a) identify your relevant area of expertise and provide a curriculum vitae setting out the details of that expertise, including the relevant expertise and curriculum vitae's of anyone that assists you with this report (to be attached to your report);

(b) only address matters that are within your expertise;

(c) where you have used factual or data inputs please identify those inputs and the sources;

(d) if you make assumptions, please identify them as such and confirm that they are in your opinion reasonable assumptions to make;

(e) if you undertake empirical work, please identify and explain the methods used by you in a manner that is accessible to a person not expert in your field;

(f) confirm that you have made all the inquiries that you believe are desirable and appropriate and that no matters of significance that you regard as relevant have, to your knowledge, been withheld from your report; and

(g) please do not provide legal advocacy or argument and please do not use an argumentative tone.

All key source materials referenced by you in your report should be provided to APT with your report.

Confidentiality

Please ensure that any confidential information provided to you by APTPPL for the purposes of drafting your report is kept confidential, and that any confidential information is not disclosed to any person without the consent of APTPPL.

Your report, and potentially all key source material, will be provided to the AER as part of APTPPL's revised proposal. All non-confidential material will be published by the AER on its website, including your report. As such, should your report contain any information which is confidential, this material must be clearly identified by you as confidential at the time your report is finalised.

Appendix 2: CV of Prof 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 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.

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

Chan, K-F., R. Brooks, S. Treepongkaruna and S. Gray, (2011), "Do Trading Hours Affect Volatility Links in the Foreign Exchange Market?" *Australian Journal of Management*, forthcoming.

Chan, K-F., R. Brooks, S. Treepongkaruna and S. Gray, (2010), "Asset market linkages: Evidence from financial, commodity and real estate assets," *Journal of Banking and Finance*, forthcoming.

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

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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.

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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.

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 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.)

Consulting

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

Consulting interests and specialties, with recent examples, include:

- **Corporate finance**
  - ⇒ **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.