Market risk premium

Report 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 market risk premium (**MRP**) 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 is the appropriate methodology to be adopted when calculating the MRP, and what is the appropriate value to be adopted for the MRP? That is, what methodology and value should be adopted that will provide a MRP 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 6% is an appropriate estimate of the long-run average MRP;
>
> (b) that the AER has previously used 6.5% to reflect higher risk premiums during times of market volatility and uncertainty;
>
> (c) current indications as to the likely levels of risk premiums in financial markets over the regulatory period for which the revised access arrangement is to apply (2012 – 2017);
>
> (d) current indications as to the likely levels of risk premiums in financial markets over the regulatory period for which the revised access arrangement is to apply (2012 – 2017); and
>
> (e) how the assumed value of dividend imputation franking credits affects the estimate of MRP.

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 MRP that differs from the AER's estimate of MRP 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 (**Envestra 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**).

6. This report addresses the issues relating to MRP from the SoRI and from the four recent final decisions that are listed above.

7. In those recent decisions, the AER sets out its view that:

   a. Whereas the appropriate estimate of MRP was 6.5% in mid-2009, commensurate with conditions in financial markets at that time;

   b. Conditions in financial markets have since improved so that the long-run average estimate of 6% is now appropriate.

Main conclusions

8. My main conclusions are:

   a. The AER's previous estimate of 6.5% should not be treated as an upper bound on MRP estimates because it was not based on any analysis;

   b. Indicators of conditions in financial markets establish that risk premiums remain at elevated levels (option implied volatilities, dividend yields and yield spreads in debt markets all remain well above long-run averages);

   c. The AER indicates that it has placed some reliance on geometric averages of historical data. It is incorrect to do so, and correcting that error would lead to higher estimates of MRP;

   d. The AER places some reliance on macroeconomic commentary. More direct evidence about the current conditions in the market for funds can be obtained from current prices in the market for funds, than from the text of various pieces of macroeconomic commentary;

   e. All MRP estimates must be "grossed up" to reflect the assumed value of dividend imputation franking credits – such that internal consistency is preserved throughout the WACC estimation process. In this regard, survey estimates that make no allowance for

franking credits cannot be compared with an AER estimate that *does* reflect an assumed value of franking credits; and

f. Given:

   i. An unconditional mean estimate of 6% (from recent AER decisions);

   ii. A standard deviation of the unconditional mean of 1.5% (from Handley, 2011); and

   iii. The ability of conditioning variables (such as option implied volatilities, dividend yields and yield spreads in debt markets) to explain 50% of the variation in longer-term excess returns (from the empirical finance literature),

an appropriate range for MRP estimates is 4-8%. Since the current values of the conditioning variables is more than one standard deviation above their long-run mean values, an estimate of at least 7% would be commensurate with the current conditions in the market for funds.

1. Summary of AER's current views about estimates of MRP

View on MRP expressed in the SoRI

9. The AER view is that:

   a. The best long-run average estimate of MRP is 6%; and that

   b. The MRP varies from time to time with changing conditions in financial markets, in which case the best estimate of MRP is above 6% at some points in time and below 6% at others.

10. For example, in the SoRI in May 2009 the AER concluded that:

> …prior to the onset of the global financial crisis, an estimate of 6 per cent was the best estimate of a forward looking long term MRP, and accordingly, under relatively stable market conditions—assuming no structural break has occurred in the market—this would remain the AER's view as to the best estimate of the forward looking long term MRP.[1]

11. In the SoRI the AER further concluded that:

> …while theoretically the MRP could avary [sic] over time in line with different economic conditions the view of the AER and the JIA's advisers (Professor Officer and Dr Bishop) is that, unlike for the nominal risk-free rate, there is no adequate method to automatically update the MRP at the time of each reset determination.
>
> Yet the NER requires the AER to lock in either a value or method for each parameter. Given the lack of an appropriate method that could be used to update the MRP for each reset determination effected by this WACC review, the only alternative is that a value for the MRP be adopted.
>
> In relatively stable market conditions, the adoption of a value for the MRP (which then applies for multiple reset determinations) is unlikely to be a significant issue, as the long term estimate is likely to be the best estimate of forward looking expectations prevailing at any particular point in time.
>
> However, due to the global economic and financial crisis, relatively stable market conditions do not currently exist. While it is conditions at the time of the reset, rather than at the time of the WACC review which are relevant, the AER has taken into account current conditions to the extent these conditions are expected to prevail over the time of reset determinations affected by this review. In other words, as the AER is reviewing the WACC parameters now—including 'locking-in' a value for the MRP—to the extent that current conditions (at the time of this review) are expected to be maintained until the time of the determinations effected [sic] by this review, then current conditions remain a relevant consideration in determining what value should be 'locked-in' for the MRP.[2]

[1] SoRI, p. xiv.
[2] SoRI, pp. 44-45.

AER's current view

12. The recently expressed view of the AER is that:

    a. At the time of the SoRi (May 2009) financial market conditions were such that the best estimate of MRP was 6.5%; but that

    b. Conditions in financial markets are now such that the best estimate of MRP is the long-run average estimate of 6%.

13. In the SoRI, the AER concluded that:

> …relatively stable market conditions do not currently exist and taking into account the uncertainty surrounding the global economic crisis…the AER considers that a MRP of 6.5 per cent is reasonable, at this time, and an estimate of a forward looking long term MRP commensurate with the conditions in the market for funds that are likely to prevail at the time of the reset determinations to which this review applies.[3]

14. In four recent final decisions, the AER has concluded that:

> The significant uncertainty that characterised markets at the time of the WACC review has substantially diminished. The prevailing conditions in the market for funds have eased.[4]

and

> The AER considers the evidence outlined above supports an MRP of 6 per cent as the best estimate of the MRP. It also indicates that the AER's approach of increasing the MRP to 6.5 per cent at the time of the WACC review is no longer appropriate.[5]

Interpretation of AER's Global Financial Crisis (GFC) estimate of 6.5%

15. In relation to the Global Financial Crisis (**GFC**) MRP estimate of 6.5%, Inote that there is widespread agreement that the AER was correct to increase its estimate of the MRP during the GFC. There is less agreement about the magnitude of this increase and about the method by which that magnitude was determined. In particular, the SoRI provides no analysis of why the appropriate adjustment to the estimate of MRP (to reflect the effect of the GFC) is precisely 50 basis points.

16. An adjustment of 50 basis points is very small relative to the confidence intervals around any estimate of MRP. For example, in his most recent report for the AER, Handley (2011) reports that the 95% confidence interval for the point estimate of MRP based on data since 1958 (the period that is said to contain the most reliable data) is 1,267 basis points.[6] This is more than 25 times the AER's 50 basis point adjustment in relation to the effects of the GFC. That is, the 50 basis point adjustment is very small, even relative to the estimation error surrounding the point estimate.

[3] SoRI, pp. xiv-xv.
[4] Amadeus Final Decision, p. 71; Allgas Qld Final Decision, p. 33; Envestra Qld Final Decision, p. 45; SA Final Decision, p. 50.
[5] Amadeus Final Decision, p. 72; Allgas Qld Final Decision, p. 34; Envestra Qld Final Decision, p. 46; SA Final Decision, p. 51.
[6] Handley (2011) Table 1, p. 5.

17. Moreover, the 50 basis point adjustment in the SoRI is not based on any calculations or modelling or analysis. Rather, the AER selected an estimate of 6.5% on the basis that:

> …having regard to the desirability of regulatory certainty and stability, the AER does not consider that the weight of evidence suggests a MRP significantly above 6 per cent.[7]

18. It might be argued that if 6.5% was an appropriate estimate of the MRP during the height of the GFC, and if the effects of the GFC have reduced, then the current estimate of MRP should be somewhat lower than 6.5%. However, this presupposes that 6.5% *was* an appropriate estimate of the MRP during the height of the GFC. But, as set out above, the SoRI provides no analysis of why the appropriate adjustment to the estimate of MRP (to reflect the effect of the GFC) was precisely 50 basis points. The 50 basis point adjustment was not based on any calculations or modeling. Rather, the AER selected an estimate of 6.5% "having regard to the desirability of regulatory certainty and stability."[8] Moreover, the 50 basis point increase is a relatively small adjustment given that almost all financial indicators of risk were at their highest levels for decades. For these reasons, it is my view that the 6.5% estimate should not be treated as any sort of theoretical or empirical maximum upper bound for MRP estimates.

[7] SoRI, p. 238.
[8] SoRI, p. 238.

2. Current conditions in financial markets

Do risk premiums in financial markets remain at elevated levels?

19. To determine whether financial market risk premiums remain at elevated levels, the standard approach is to examine a time series of variables that have been shown in the finance literature to be related to market risk premiums. The variables that are examined include:

    a. Option implied volatilities – higher implied volatilities indicate higher levels of market risk and consequently higher risk premiums;

    b. The spread between the yields on highly-rated bonds and lower-rated bonds – a greater spread indicates that risk premiums are high in financial markets generally; and

    c. Dividend yields – a higher dividend yield indicates that prices are low relative to dividends, which is consistent with dividends being discounted back to present value using a higher discount rate, which is in turn consistent with higher risk premiums.

20. Fama and French (1988), Fama and French (1989) and Keim and Stambaugh (1986) demonstrate that dividend yields and default spreads are positively associated with future equity market returns relative to Treasury bill rates. This does not imply that equity market returns can be forecast with absolute precision or that these variables provide investors with a trading strategy which generates abnormally high returns. What it does imply is that the bond and equity market prices appear to be affected by similar risk considerations. This means that low equity prices (relative to trailing dividends) and low corporate bond prices (relative to promised repayments) reflect investors' expectations for risk and therefore their required return for bearing that risk, in both the equity and debt markets.

21. In the remainder of this section, I examine a time series of each of these variables in turn.

Option implied volatilities

22. In the Australian market, it is most common to estimate the implied volatility of the broad market using options on the ASX 200 index. These implied volatilities are computed by determining the volatility estimate that would have to be inserted into the Black-Scholes option pricing formula in order to reconcile the model price with actual traded market prices. Prices for relatively short-term at-the-money call and put options are usually used for this purpose.

23. This series measures the market's perception of the forward-looking volatility of the ASX 200 index. It is therefore a measure of the *amount* of risk that market participants perceive. This is not a perfect measure of the Capital Asset Pricing Model (**CAPM**) MRP for two reasons:

    a. It is based on options with a relatively short (3 month) time horizon; and

    b. It reflects only the *amount* of risk, whereas the CAPM MRP also reflects the *price* of risk – the return that investors require for bearing each unit of risk. Both of these components, and hence the MRP, can vary over time.

24. In its recent final decisions, the AER notes that it is difficult to precisely model the relationship between option implied volatility and MRP and that there is no consensus in the relevant literature about how this should be done or even whether this can be done.[9]

25. Nevertheless, it is clear and well-accepted that there is a positive relationship between implied volatilities and the forward-looking MRP. Higher implied volatilities are indicative of higher risk and consequently higher risk premiums. That is, when implied volatilities are materially above their long-run average level, risk premiums will also be above their long-run average levels.

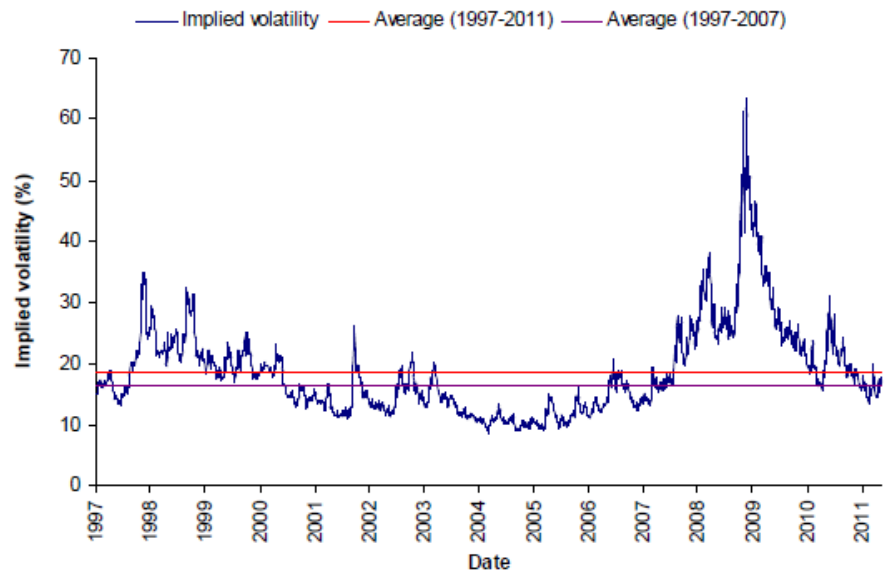
26. Since implied volatilities provide an indication of the market's view about volatility over the life of the option, they provide a forward-looking view of stock market volatility. This is relevant to the estimation of MRP in that volatility is a measure of the *quantity* of risk that is associated with an equity investment – a greater amount of risk would logically require a greater premium as compensation for bearing it.

27. Although it is difficult to precisely quantify this relationship, the directional effect is well accepted. For example, in its recent final decisions, the AER accepts that there is a positive relationship between option implied volatility and MRP. The AER then further argues that implied volatilities have retreated to pre-GFC levels, in which case the MRP estimate should be reduced to its long-run average level of 6%:

> implied volatility appears to have reduced significantly since the height of the GFC and is currently consistent with levels experienced prior to the GFC, which can be seen from figure A.4.[10]

28. The basis for this conclusion is the figure that is reproduced below. This same figure appears in Appendix 1 of the AER's four recent final decisions.

Figure A.4 Implied volatility from prices of 3 month options on the ASX200 index

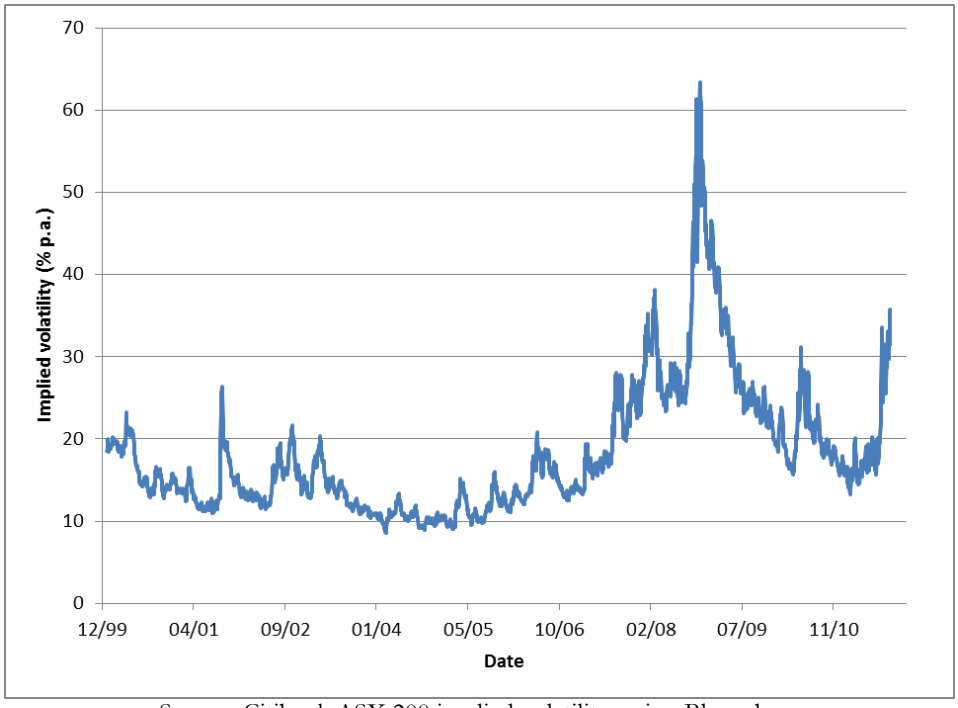


Source: AER analysis

[9] Allgas Qld Final Decision, p. 133; Envestra Qld Final Decision, p. 184; SA Final Decision, p. 196.
[10] Amadeus Final Decision, p. 158; Allgas Qld Final Decision, p. 133; Envestra Qld Final Decision, p. 184; SA Final Decision, p. 196.

29. An updated version of this figure is set out in Figure 1 below. It is clear that in recent times the implied volatility from option prices is substantially higher than its average value. This is consistent with the proposition that the effects of the GFC have not completely washed through the system, that risk premiums remain at elevated levels, and that an MRP estimate above the long-run average estimate of 6% would be appropriate in the current circumstances. In particular, the most recent observation of implied volatility is 35.7%, which is greater than 96% of the observations and more than 2.16 standard deviations above the mean since 1 January 2000.

Figure 1. Option implied volatility



Source: Citibank ASX 200 implied volatility series, Bloomberg

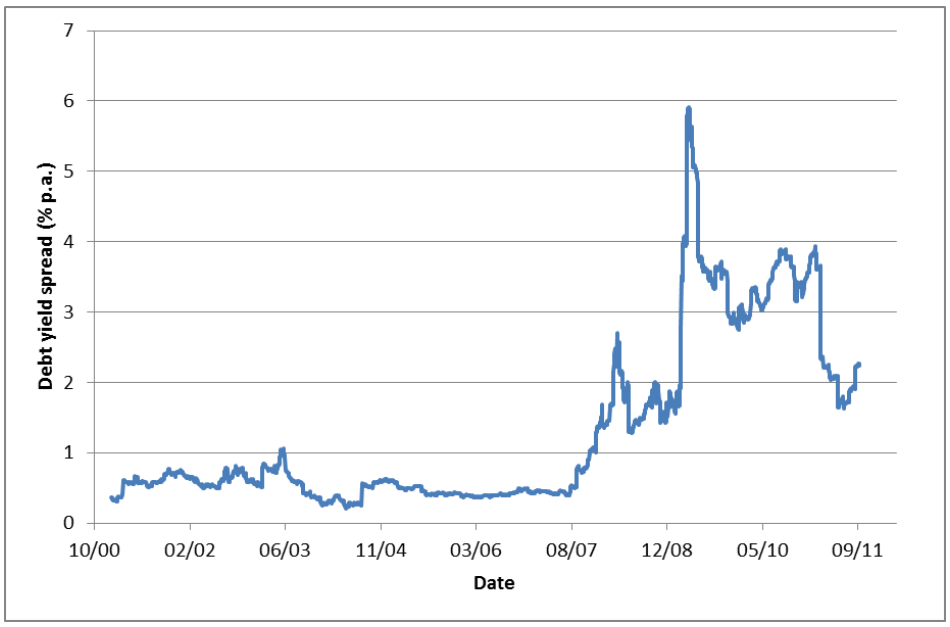
Yield spreads in debt markets

30. The *default spread* is measured as the difference between an index of the yield to maturity on BBB-rated bonds and a corresponding index of AAA-rated bonds. This spread proxies for credit or default risk. During economic expansions, the spread between the yields on higher- and lower-rated bonds tends to be low as risk premiums are also low. During recessions, however, the spread widens, commensurate with an increase in risk premiums generally.

31. Figure 2 below plots the spread between the DataStream AAA and BBB yield estimates. This figure shows that risk premiums in debt markets have reduced since the peak of the GFC, but remain at levels much higher than before the GFC. In particular, the most recent observation of the yield spread is 2.259%, which is greater than 80% of the observations and more than 0.77 standard deviations above the mean since 1 January 2000.

32. In my view, this is evidence supporting the proposition that risk premiums in equity markets are also likely to remain at elevated levels and not to have reduced to pre-GFC levels. In particular, it would be highly unlikely that investors would currently require materially higher than average risk premiums when investing in a firm's bonds, but not when investing in the same firms' shares.

Figure 2. Spread between AAA and BBB bonds



Source: Datastream

33. In its recent final decisions, the AER rejects the consideration of the elevated risk premiums in debt markets on two bases:

    a. That the evidence on debt premiums is unreliable in which case it cannot be concluded that risk premiums in debt markets *are* at elevated levels;

> there is a significant paucity of data on long-term bonds with credit ratings close to BBB. This is likely to reduce the accuracy of yield forecasts for long-term BBB rated corporate bonds, such as those referred to by SFG and VAA.[11]

    b. In any event the evidence about risk premiums in debt markets is irrelevant because debt and equity markets are (or can be) completely disjointed.

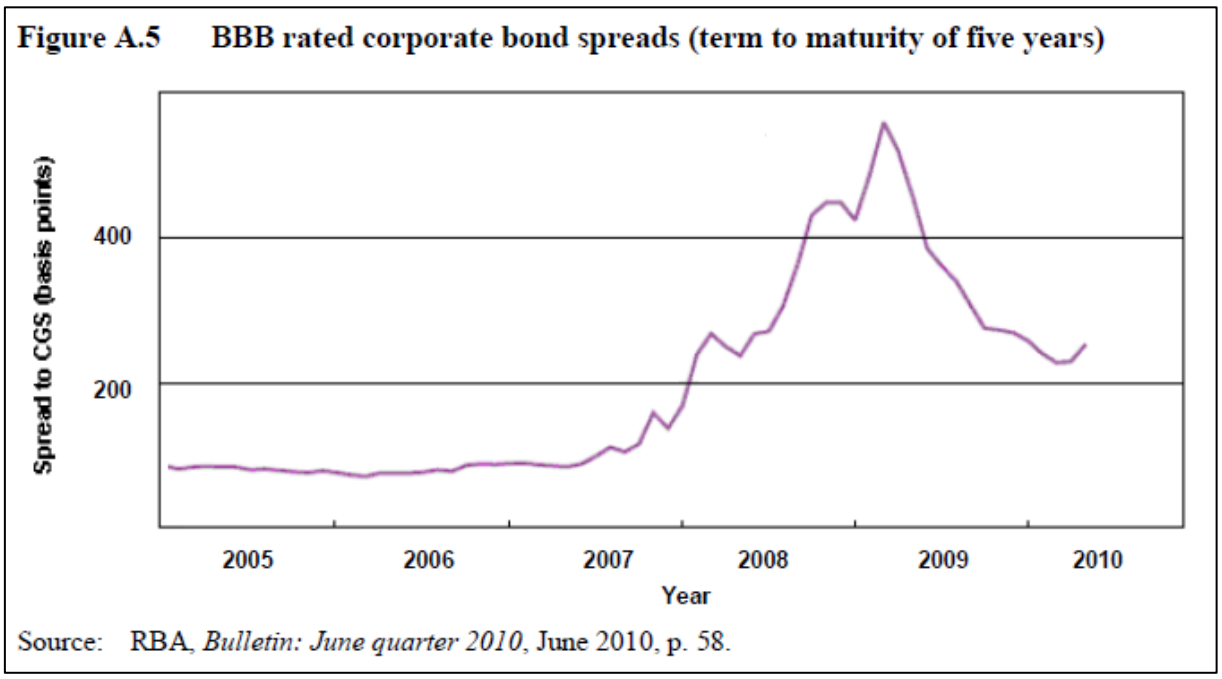
> It is also not unreasonable for conditions in debt and equity markets to differ from each other over time.[12]

34. The AER's first argument can be addressed empirically. *Every* indicator of yield spreads in debt markets currently shows spreads remaining at elevated levels. This includes spread estimates published by the RBA and cited by the AER in its recent final decisions,[13] such as is reproduced in Figure 3 below. It also includes spread estimates based on shorter-term bonds. Indeed, the Datastream estimates in the figure above are based on corporate bonds of *all* maturities, not just long-term bonds as the AER suggests in its recent final decisions. Moreover, the AER's *own* estimate of the BBB+ debt premium in all four of its recent final decisions is well above pre-

[11] Amadeus Final Decision, p. 162; Allgas Qld Final Decision, p. 138; Envestra Qld Final Decision, p. 188; SA Final Decision, p. 201.
[12] Amadeus Final Decision, p. 163; Allgas Qld Final Decision, p. 139; Envestra Qld Final Decision, p. 189; SA Final Decision, p. 201.
[13] Amadeus Final Decision, p. 167; Allgas Qld Final Decision, p. 142; Envestra Qld Final Decision, p. 194; SA Final Decision, p. 185.

GFC levels. In my view, the contention that debt risk premiums are not currently at elevated levels is simply unarguable.

Figure 3. RBA Spread between AAA and BBB bonds



Source: Amadeus Final Decision, p. 167.

35. In my view, the second argument set out above defies logic. It is impossible that investors would currently require substantially higher risk premiums when investing in a firm's bonds, but no more than the long-run average premium when investing in the same firm's shares. The recent final decisions simply assert that the same investors might, for some unstated reason, believe that substantially higher risk premiums are warranted when buying a firm's bonds, but not when buying the same firm's shares.

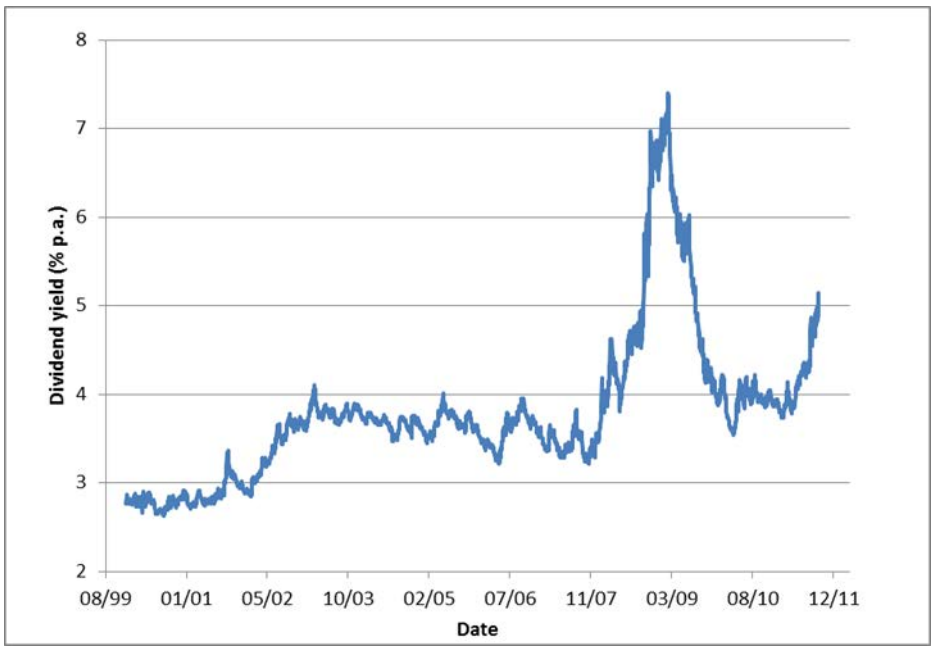
36. At the very least, there must be a prima facie case that when risk premiums are materially higher in one segment of financial markets (even according to the AER's own estimates) they are also likely to be higher in other segments of financial markets. Such a prima facie case cannot be dismissed by mere assertion.

Dividend yields

37. The dividend yield is the ratio of the cash flow to shareholders by way of dividends (including payments of a return of capital and payments in relation to loan notes) to the price of the stock. When dividend yields are high, a given set of cash flows is being discounted at a higher rate, indicative of higher equity risk premiums.

38. Figure 4 shows a time series of dividend yields from January 2000 to the present. There was a clear and dramatic increase in dividend yields during the height of the GFC. Yields have since fallen, but remain above the pre-GFC levels. The current dividend yield is 5.14%, which is larger than 92% of the observations and more than 1.59 standard deviations above the mean since 1 January 2000.

Figure 4. Dividend yield on ASX 200 index



Source: Datastream

39. Many papers in the empirical finance literature (including Fama and French, 1988; Fama and French, 1989; and Keim and Stambaugh, 1986) demonstrate that dividend yields are strongly correlated with future excess stock returns. Consequently, the fact that dividend yields are currently at historically high levels indicates that market risk premiums remain at elevated levels.

Conclusions

40. The conclusions that can be drawn from the analysis set out above are:

    a. The GFC had a pronounced effect on market risk premiums during the height of the crisis;

    b. All indicators suggest that this effect has reduced since the peak of the GFC; and

    c. These indicators remain materially above their pre-GFC levels.

41. In my view, the available financial market data supports the conclusion that the effects of the GFC have reduced, but they continue to affect risk premiums in financial markets. The available financial market data does not support the conclusion that investors view the amount of risk involved in holding a broad portfolio of equities and the price of risk (the additional return that is required in relation to each unit of risk) as now being the same as before the GFC. In my view, the turmoil in financial markets surrounding the GFC continues to have a clear effect on risk premiums in financial markets.

3. Time horizon and method of averaging

AER estimate is based, in part, on geometric averages

42. In its four recent final decisions, the AER sets out its view that a 10-year horizon is appropriate when estimating MRP:

> the AER considers it appropriate to calculate the MRP with the assumption of a 10 year investment horizon.[14]

43. Presumably this means that, when estimating MRP, one should think about the average annual return over a 10-year period that investors would require from an equity investment in the average firm.

44. The recent final decisions then link this 10-year horizon with the method of averaging that should be applied to historical data when estimating MRP:

> arithmetic mean estimates of realised annual excess returns are likely to overstate realised excess returns over a 10 year time horizon because they do not take account of the cumulative effect of returns over a 10 year time horizon.[15]

and

> the AER notes that the arithmetic means of historical excess returns are likely to be overstated to some degree. The best estimate of historical excess returns over a 10 year period is likely to be somewhere between the geometric mean and the arithmetic mean of annual excess returns.[16]

45. In this context, an arithmetic average is computed by adding the observations over the sample period and then dividing by the number of observations:

$$\text{Arithmetic Average} = \frac{r_1 + r_2 + \ldots + r_N}{N}$$

whereas a geometric average is computed as:

$$\text{Geometric Average} = \left[(1+r_1)\times(1+r_2)\times\ldots\times(1+r_N)\right]^{1/N} - 1.$$

46. The recent final decisions do not state precisely how the AER used arithmetic and geometric averages of historical excess returns data – other than to suggest that the best estimate of MRP for a 10-year horizon is likely to be somewhere between the arithmetic and geometric averages and that:

[14] Amadeus Final Decision, p. 151; Allgas Qld Final Decision, p. 122; Envestra Qld Final Decision, p. 173; SA Final Decision, p. 185.
[15] Amadeus Final Decision, p. 153; Allgas Qld Final Decision, p. 127; Envestra Qld Final Decision, p. 178; SA Final Decision, p. 190.
[16] Amadeus Final Decision, pp. 153-154; Allgas Qld Final Decision, p. 128; Envestra Qld Final Decision, p. 179; SA Final Decision, p. 191.

> the point estimates calculated on both an arithmetic and a geometric mean basis are still relevant and should inform the best estimate of the MRP.[17]

No reliance should be placed on geometric averages

47. It is wrong to place *any* reliance on geometric averages. To the extent that reliance is (incorrectly) placed on geometric averages, the resulting estimate of MRP will be downwardly biased.

48. The issue of whether historical estimates of MRP should be based on arithmetic or geometric averages is dealt with in detail in the well-known Harvard Business School case relating to Marriott Corporation. The instructor solutions to that case note that it is the *expected* annual return that is relevant when estimating MRP and that:

> Students focusing on the geometric average will argue that it is the appropriate growth rate of an investment…However, the arithmetic average is a better measure of the *expected* return on an investment.

49. The instructor solutions are quite clear about which approach should be used to estimate MRP:

> The arithmetic average annual return is the correct measure of the expected annual return.

50. The solutions go on to explain that:

> Suppose, for example, that a two-period investment has two equally likely outcomes: a 40% return or a -20% return. The average returns are:
>
> $$\text{Arithmetic Average} = \frac{40 + (-20)}{2} = 10\%$$
>
> $$\text{Geometic Average} = \sqrt{1.40 \times 0.80} - 1 = 5.8\%$$
>
> To see that the arithmetic average is the correct measure of expected return, compute the return associated with each possible outcome. Assume that $1,000 is invested and that the returns conform to the expected frequency distribution [i.e., half the time the return will be 40% and half the time it will be -20%].

Year	0	1	2	Terminal value	Probability
	1000	40%	40%	1,960	0.25
	1000	40%	-20%	1,120	0.25
	1000	-20%	40%	1,120	0.25
	1000	-20%	-20%	640	0.25
Probability-weighted average				1,210	

[17] Amadeus Final Decision, p. 153; Allgas Qld Final Decision, p. 127; Envestra Qld Final Decision, p. 178; SA Final Decision, p. 190.

> Thus, the expected return is the arithmetic average return: $1{,}000 \times (1.10)^2 = 1{,}210$.

51. The Harvard case solutions also contain a more detailed example that considers a 10-year time horizon. It is clear about the fact that even with a 10-year time horizon, the arithmetic average must be used. Not the geometric average. Not something between the arithmetic and geometric averages.

52. Suppose the goal is to estimate an expected annual return over the next 10-years, consistent with the AER view. To see why the expected annual (compound) return is the arithmetic average, continue the previous example where there is a 50/50 chance of the return being 40% or -20% over the course of a year. In the context of historical data, suppose a sample period of 50 years was used and that in 25 of those years there was a return of 40% and in 25 of them there was a return of -20%. In this case:

    a. the arithmetic average return is 10% p.a.; and

    b. the geometric average return is 5.83%.

53. Now the question is: if stock market returns over the next 10 years occur with the same relative frequency as they did over the last 50 years, what annual compound return should we expect over the next 10 years?

54. This question can be answered by examining the outcome of every possible sequence of returns over the next 10 years and by determining the probability of each. For example, it is possible that the return will be 40% in every one of the 10 years and the value of an initial investment of $100 will accumulate to:

$$100 \times (1.40)^{10} = 2{,}892.55.$$

55. However, the probability of 10 "good" years in a row is only 0.1% (the same as the chance of tossing a coin 10 times and getting 10 heads).

56. Similarly, if the next 10 years produces nine with a 40% return and one with a -20% return, the accumulated value of a $100 investment will be:

$$100 \times (1.40)^9 \times (0.80)^1 = 1{,}652.88.$$

57. The probability of this occurring is approximately 1% (which is 10 times higher than in the previous case, since the -20% return could be in any one of 10 positions – Year 1 or Year 2, and so on). Note that this is the same as the probability of getting 9 heads out of 10 coin tosses.

58. All of the possible outcomes, and the probability of each occurring, are set out in Table 1 below.

Table 1. Probability distribution of potential investment payoffs

Number of 40% years	Number of -20% years	Probability	Accumulated value	Average compound annual return
10	0	0.0010	2,892.55	40.00%
9	1	0.0098	1,652.88	32.38%
8	2	0.0439	944.50	25.18%
7	3	0.1172	539.72	18.36%
6	4	0.2051	308.41	11.92%
5	5	0.2461	176.23	5.83%
4	6	0.2051	100.71	0.07%
3	7	0.1172	57.55	-5.38%
2	8	0.0439	32.88	-10.53%
1	9	0.0098	18.79	-15.40%
0	10	0.0010	10.74	-20.00%
Expected payoff			**259.37**	

59. The *expected* accumulated value (at the end of 10 years) is $259.37. Note that this implies an annual return of 10% (which is precisely the arithmetic average):

$$100 \times (1.10)^{10} = 259.37.$$

60. Hence, if the relevant question is:

> if stock market returns over the next 10 years occur with the same frequency as they did over the last 50 years, what annual compound return should we expect over the next 10 years?

which it is, the answer is the arithmetic average return – which in this case is 10%.

61. The mistake that is made by using the geometric average is to confuse the *expected* return with the return from the *most likely* scenario. Note that the annual return from the most likely scenario is 5.83% – the geometric mean. The MRP in the CAPM is an expected return, not a return from the most likely scenario. Consequently, the arithmetic mean, and not the geometric mean *must* be used.

Conclusion

62. To the extent that the AER has relied on geometric mean estimates in its recent final decisions, it is in error and its estimates must be corrected upwards to what they would have been had there been no reliance on geometric means.

4. Grossing up for the assumed value of franking credits

63. In the recent final decisions[18] the estimates of MRP from historical stock return data have been "grossed up" to reflect the assumed value of theta of 0.35. It is correct to gross up estimates of MRP to reflect the assumed value of imputation credits to ensure internal consistency between the estimate of MRP and the estimate of gamma.

64. The total return on equity consists of three components – dividends, capital gains and dividend imputation franking credits. The stock index data that forms the basis of the historical data used to estimate MRP reflects only dividends and capital gains. Consequently, the assumed value of franking credits must be added to the historical MRP estimate via a procedure known as "grossing up."

65. The grossing up calculations were performed for the AER by Associate Professor Handley. I have no reason to doubt those calculations, but note that the details of those calculations have not been made public.

[18] Amadeus Final Decision, p. 154; Allgas Qld Final Decision, p. 128; Envestra Qld Final Decision, p. 179; SA Final Decision, p. 191-192.

5. Qualitative information relied upon in recent AER decisions

Overview

66. In its four recent final decisions, the AER has made use of two types of qualitative information in its considerations of MRP:

    a. Survey responses and market practice; and

    b. Macroeconomic commentary.

67. In this section, I set out my views about how this qualitative information should be interpreted and about how much weight should be afforded to it.

Survey responses

68. In its recent final decisions, the AER concludes that:

> survey based estimates of the MRP are relevant for consideration along with the range of other evidence on the MRP.[19]

69. Surveys can be useful when asking questions about what people actually do (e.g., whether or not their company regularly uses the CAPM to estimate the required return on equity). However, questions about what people think might happen in the future (e.g., how much the stock market might go up over some future period) are of very limited use.

70. Moreover, the AER's recent final decisions do not state *how* the AER used the survey evidence in reaching its conclusion about MRP, nor do they even set out *what* estimate the AER thinks is supported by the survey evidence.

71. The recent final decisions are also unclear about whether the AER has made any adjustment to survey estimates of MRP to reflect the assumed value of franking credits. The survey estimates of MRP reflect no value for franking credits, whereas the AER has adopted a value of theta of 0.35. To create a like-with like comparison, estimates of MRP that are ex-franking credits must be adjusted for the AER's assumed value of franking credits. In this regard, the final decisions state the AER's view that:

> the estimation of MRP is imprecise and it may not be appropriate to explicitly adjust survey based estimates of the MRP for an assumed theta value that is as low as 0.35.[20]

72. It is not clear whether the AER made any adjustment for the assumed value of franking credits (as they should have), what value of MRP they believe the survey evidence supports, or how they used that information in determining their final estimate of MRP.

[19] Amadeus Final Decision, p. 161; Allgas Qld Final Decision, p. 137; Envestra Qld Final Decision, p. 188; SA Final Decision, p. 200.

[20] Amadeus Final Decision, p. 161; Allgas Qld Final Decision, p. 137; Envestra Qld Final Decision, p. 188; SA Final Decision, p. 200.

Observed market prices vs. macroeconomic commentary

73. The four recent final decisions note that the AER has placed some reliance on various pieces of macroeconomic commentary:

> The economic and financial markets outlook for Australia is robust as noted in statements by the Reserve Bank of Australia (RBA), the International Monetary Fund (IMF) and the Organisation for Economic Co-operation and Development (OECD). This is likely to be factored into investors' expectations of future equity market returns and therefore the MRP required by investors.[21]

74. However, the final decisions are unclear about how much weight the AER has applied to this macroeconomic commentary or what estimate of MRP it believes the commentary supports.

75. This commentary is indirect evidence at best and should be afforded little weight in comparison to observed market data. No other WACC parameters are estimated with reference to commentary. Presumably this commentary also touches on the issue of interest rates, but the risk free rate is estimated from market prices without reference to any commentary.

76. Moreover, there is a distinction between forecasts of macroeconomic conditions and the prevailing conditions in the market for funds. More direct evidence about the current conditions in the market for funds can be obtained from current prices in the market for funds, than from the text of various pieces of macroeconomic commentary.

Conclusions in relation to qualitative information

77. In my view, the best information about the prevailing conditions in the market for funds comes from traded prices drawn from the market for funds, rather than from survey responses or macroeconomic commentary. Consequently, I give no material weight to this qualitative information.

[21] Envestra Qld Final Decision, p. 47; SA Final Decision, p. 52.

6. Conclusion on appropriate value of MRP

Unconditional MRP estimate

78. In its four recent final decisions, the AER has reaffirmed its conclusion in the SoRI that the appropriate long-run average estimate of MRP is 6%. The four recent final decisions refer to historical MRP estimates prepared by Handley (2011). That report notes that the standard error of the mean historical MRP estimate is 1.5% if the longest available sample period is used. This is the most precise estimate of mean historical excess returns that is available. I also note that this standard error is insensitive to the assumed value of franking credits since, once an assumed value has been selected, the grossing-up for franking credits is stable over time.

79. In summary, the AER's recent final decisions adopt an historical long-run average MRP estimate of 6% with standard error of 1.5%. Statistically, this is an estimate of the unconditional mean of a random variable. I represent this using the following notation:

$$\bar{r}_{t,T} \sim N(6\%, 1.5\%)$$

where $\bar{r}_{t,T}$ represents the average annual excess return between time t and time T, where that time period is considered to be a long-run period.

80. In the regulatory setting, the task is to estimate $\bar{r}_{t,T}$ in a manner that is consistent with the prevailing conditions in the market from time to time. The way to interpret the distribution above is as follows: At the time of the regulatory re-set, nature draws a value of $\bar{r}_{t,T}$ from the above distribution and the role of the regulator is to compute an estimate of what value of $\bar{r}_{t,T}$ has been drawn from the distribution on this occasion. The best *unconditional estimate* of $\bar{r}_{t,T}$ is 6%, but it must be recognised that the true value of $\bar{r}_{t,T}$ might be as low as 3% or as high as 9% on some occasions (this being the 95% confidence interval). Ideally, the regulator would have information about when an estimate as low as 3% would be appropriate and when an estimate as high as 9% would be appropriate. In the absence of any such information, the unconditional estimate of 6% should be used. However, I demonstrate below that there is presently substantial information to suggest that an MRP estimate above the long-run mean estimate of 6% is appropriate in the current market circumstances.

Conditional MRP estimate

81. As set out in Section 2 of this report, the empirical finance literature notes that a number of variables are strongly predictive of future excess returns. Consequently, the best estimate of future excess returns is one that is conditional on these predictive variables. That is, we may be able to use these variables to determine the circumstances in which it would be appropriate to adopt an estimate of MRP above (or below) the unconditional estimate of 6%.

82. To see how this might be done, I first denote the conditional mean excess return as $E(\bar{r}_{t,T} \mid I_t)$, where I_t represents all of the relevant conditioning variables, observed as at the date of the prediction.[22]

83. This allows us to write:

[22] That is, I_t represents the "information set" at the time of making the prediction.

$$\bar{r}_{t,T} = E\left(\bar{r}_{t,T} \mid I_t\right) + \varepsilon_t$$

where ε_t is mean zero noise, conditional on I_t.

84. Fama and French (1988, 1989) and Keim and Stambaugh (1986) show that for long time horizons the conditioning variables can explain half of the variance of $\bar{r}_{t,T}$. That is, the R^2 statistic in the regression equation in the previous paragraph is in the order of 50%. To see the effect of this, note that:

$$Var\left[\bar{r}_{t,T}\right] = Var\left[E\left(\bar{r}_{t,T} \mid I_t\right)\right] + Var\left[\varepsilon_t\right]$$

85. An R^2 statistic of 50% implies that:

$$Var\left[E\left(\bar{r}_{t,T} \mid I_t\right)\right] = Var\left[\varepsilon_t\right] = \frac{Var\left[\bar{r}_{t,T}\right]}{2}.$$

86. In this case we have:

$$Var\left[E\left(\bar{r}_{t,T} \mid I_t\right)\right] = \frac{Var\left[\bar{r}_{t,T}\right]}{2} = \frac{0.015^2}{2} = 0.000113,$$

which implies that the standard deviation of $E\left(\bar{r}_{t,T} \mid I_t\right)$ is approximately 1% p.a.

87. By the law of iterated expectations, $E\left[E\left(\bar{r}_{t,T} \mid I_t\right)\right] = E\left[\bar{r}_{t,T}\right]$, which is 6% in this case. Consequently, $E\left(\bar{r}_{t,T} \mid I_t\right) \sim N(6\%, 1\%)$.

88. This all implies that when conditioning on variables that have been shown to be related to market risk premiums, the 95% confidence interval for the conditional expectation of the average excess return is 4% to 8% – two standard deviations around the mean estimate. When the conditioning variables are all well above their long-run mean values, risk premiums are likely to be high and an estimate toward the upper end of the range would be appropriate. Conversely, when the conditioning variables are all well below their long-run mean values, risk premiums are likely to be low and an estimate toward the lower end of the range would be appropriate. I demonstrate below that all of the conditioning variables are substantially above their long-run mean values, which suggests that an MRP estimate above the long-run mean estimate of 6% is appropriate in the current market circumstances.

Implications for estimates of MRP

89. The AER's recent final decisions together with the results from Handley (2011) suggest that the long-run annual MRP is a random variable with mean of 6% and standard deviation of 1.5%. This equates to a 95% confidence interval of 3% to 9%. The task of the regulator is to determine an estimate that is commensurate with the prevailing conditions in the market. The appropriate point estimate at a particular point in time depends upon the usefulness of conditioning variables:

    a. If the conditioning variables provide *no information* at all about the current market risk premium, one would always adopt a point estimate of 6%. It would be recognised that true value of MRP at the relevant point of time (i.e., the draw from $N(6\%, 1.5\%)$) could

be as low as 3% or as high as 9%, but since there is no information that can be used to determine whether the appropriate estimate at the particular point in time is 3% or 9% or something in between, the unconditional estimate of 6% would always be used;

b. If the conditioning variables provide *perfect information* about market risk premiums, those variables could precisely forecast when an estimate of 3% would be appropriate, when an estimate of 9% would be appropriate, and so on. In this case, if all of the conditioning variables were currently two standard deviations below their mean, the MRP would be two standard deviations below its mean and an estimate of 3% would be used. If all of the conditioning variables were currently two standard deviations above their mean, the MRP would be two standard deviations above its mean and an estimate of 9% would be used. In all cases, the conditioning variables would provide perfect information about the MRP that is commensurate with prevailing conditions in the market; and

c. If the conditioning variables provide *imperfect information* about market risk premiums, the range of predictions will be somewhere between the single point estimate in (a) above (6%) and the full range set out in (b) above (95% confidence interval of 3-9%). The range of conditional MRP estimates will depend on how much of the variability of future excess returns can be explained by the conditioning variables. If a small proportion of this variability can be explained (i.e., the conditioning variables provide a poor signal, such as would be the case when some are above and some are below their long run means so there are conflicting signals) the appropriate range of estimates would be a small region around 6%. If the conditioning variables provide a strong and consistent signal, the appropriate range would be closer to the full range of 3-9%. In the case at hand, the literature suggests that the conditioning variables can explain approximately 50% of the variation in long-term excess returns, in which case a range of 4-8% would be appropriate. That is, if the prevailing conditions are such that the conditioning variables are well above their long-run mean values, one would have strong, but not full, confidence that an estimate of MRP above its long-run mean would be appropriate in the circumstances. This would lead to an estimate toward the upper end of the range of 4-8%. Even though it is possible that the current draw of MRP is 9% (the upper bound of the 95% confidence interval), we would not be led to select an estimate that high because the conditioning variables do not provide a perfect signal.

Application to current conditions in the market for funds

90. Table 2 below shows the current values of the three conditioning variables, relative to their long-run means. All three variables are well above their long-run means and take current values that are higher than 96, 80 and 93% respectively of all post-2000 observations. This is clear evidence that risk premiums in financial markets are currently at elevated levels.

Table 2. Current and relative value of MRP conditioning variables

Conditioning variable	Mean since 2000	Current observation	Percentile rank of current observation	Number of standard deviations above mean
Option implied volatility	18.09%	35.74%	96%	2.17
Debt yield spread	1.31%	2.26%	80%	0.77
Dividend yield	3.79%	5.14%	93%	1.59

Source: Datastream, Bloomberg, SFG calculations

91. Next, I note that the current values of the three conditioning variables are 2.17, 0.77 and 1.59 standard deviations above their means, respectively. This indicates that the conditioning variables are, on average, more than one standard deviation above their means. Applying this to the range of conditional estimates of MRP, and recalling that $E(\bar{r}_{t,T} \mid I_t) \sim N(6\%, 1\%)$, yields a current point estimate in excess of 7%.

Final conclusions

92. My main conclusions are:

a. Indicators of conditions in financial markets establish that risk premiums clearly remain at elevated levels (option implied volatilities, dividend yields and yield spreads in debt markets all remain well above long-run averages);

b. Risk premiums in financial markets have not eased to pre-GFC levels and the AER has erred in concluding that they have. There is no basis for reducing the MRP estimate below the current regulatory estimate of 6.5%; and

c. For the reasons set out above, an appropriate estimate of MRP, conditional on current values of option implied volatilities, debt yield spreads and dividend yields, is in excess of 7%.

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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 market risk premium

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:

Market risk premium (MRP)

1 In calculating APTPPL's return on capital, what is the appropriate methodology to be adopted when calculating the MRP, and what is the appropriate value to be adopted for the

MRP? That is, what methodology and value should be adopted that will provide a MRP 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 6% is an appropriate estimate of the long-run average MRP;

(b) that the AER has previously used 6.5% to reflect higher risk premiums during times of market volatility and uncertainty;

(c) current indications as to the likely levels of risk premiums in financial markets over the regulatory period for which the revised access arrangement is to apply (2012 – 2017);

(d) the appropriateness, or otherwise, of using geometric averages of historical data versus arithmetic averages of historical data in calculating the MRP, and / or the use of geometric averages in informing the value for the MRP that should be adopted; and

(e) how the assumed value of dividend imputation franking credits affects the estimate of MRP.

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

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Academic Qualifications

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

Employment History

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

Academic Awards

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

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.

Parmenter, B, A. Breckenridge, and S. Gray, (2010), 'Economic Analysis of the Government's Recent Mining Tax Proposals', *Economic Papers*: *A Journal of Economics and Policy*, 29(3), September, 279-91.

Gray, S., C. Gaunt and Y. Wu, (2010), "A comparison of alternative bankruptcy prediction models," *Journal of Contemporary Accounting and Economics*, 6, 1, 34-45.

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

Costello, D., S. Gray, and A. McCrystal, (2008), "The diversification benefits of Australian equities," *JASSA*, 2008, 4, 31-35.

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

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

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

Gray, P., S. Gray and T. Roche, (2005), "A Note on the Efficiency in Football Betting Markets: The Economic Significance of Trading Strategies," *Accounting and Finance*, 45(2) 269-281.

Duffie, D., S. Gray and P. Hoang, (2004), "Volatility in Energy Prices. In V. Kaminski," (Ed.), *Managing Energy Price Risk: The New Challenges and Solutions* (3rd ed.). London: Risk Books.

Cannavan, D., F. Finn and S. Gray, (2004), "The Value of Dividend Imputation Tax Credits in Australia," *Journal of Financial Economics*, 73, 167-197.

Gray, S. and S. Treepongkaruna, (2003), "Valuing Interest Rate Derivatives Using a Monte-Carlo Approach," *Accounting and Finance*, 43(2), 231-259.

Gray, S., T. Smith and R. Whaley, (2003), "Stock Splits: Implications for Investor Trading Costs," *Journal of Empirical Finance*, 10, 271-303.

Gray, S. and S. Treepongkaruna, (2003), "On the Robustness of Short-term Interest Rate Models," *Accounting and Finance*, 43(1), 87-121.

Gray, S. and S. Treepongkaruna, (2002), "How to Value Interest Rate Derivatives in a No-Arbitrage Setting," *Accounting Research Journal* (15), 1.

Gray, P. and S. Gray, (2001), "A Framework for Valuing Derivative Securities," *Financial Markets Institutions & Instruments*, 10(5), 253-276.

Gray, P. and S. Gray, (2001), "Option Pricing: A Synthesis of Alternate Approaches," *Accounting Research Journal*, 14(1), 75-83.

Dahlquist, M. and S. Gray, (2000), "Regime-Switching and Interest Rates in the European Monetary System," *Journal of International Economics*, 50(2), 399-419.

Bollen, N., S. Gray and R. Whaley, (2000), "Regime-Switching in Foreign Exchange Rates: Evidence from Currency Options," *Journal of Econometrics*, 94, 239-276.

Duffie, D., S. Gray and P. Hoang, (1999), "Volatility in Energy Prices. In R. Jameson," (Ed.), *Managing Energy Price Risk* (2nd ed.). London: Risk Publications.

Gray, S. and R. Whaley, (1999), "Reset Put Options: Valuation, Risk Characteristics, and an Example," *Australian Journal of Management*, 24(1), 1-21.

Bekaert, G. and S. Gray, (1998), "Target Zones and Exchange Rates: An Empirical Investigation," *Journal of International Economics*, 45(1), 1-35.

Gray, S. and R. Whaley, (1997), "Valuing S&P 500 Bear Market Warrants with a Periodic Reset," *Journal of Derivatives*, 5(1), 99-106.

Gray, S. and P. Gray, (1997), "Testing Market Efficiency: Evidence from the NFL Sports Betting Market," *The Journal of Finance*, 52(4), 1725-1737.

Gray, S. (1996), "Modeling the Conditional Distribution of Interest Rates as a Regime- Switching Process," *Journal of Financial Economics*, 42, 27-62.

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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.