THE COST OF EQUITY AND THE MARKET RISK PREMIUM

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25 July 2012

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EXECUTIVE SUMMARY

This paper has sought to address a number of questions posed by the AER, and the conclusions are as follows.

The first of these questions is the validity of CEG's claim that there is a clear negative relationship between the ten year CGS yield and the ten year MRP to the extent that the ten-year cost of equity is stable over time, and therefore recent reductions in the ten-year CGS yield do not reduce the ten-year cost of equity. I do not consider that CEG present any persuasive evidence that there is a *strong* negative relationship of this kind and the primary evidence they do present in their Figure 8 is pre-disposed to that result by assuming that the future cost of equity is the same for all future years.

The second of these questions involves critically reviewing three approaches to estimating the cost of equity that are proposed by CEG, involving the DGM applied to individual firms, the DGM applied to the MRP, and averaging the risk free rate over a long period. Applying the DGM approach to individual firms is very similar to applying it to the MRP but has the additional problems of greater exposure to fluctuations in the earnings payout rate, incentives for the firms in question to manipulate their earnings payout rate, and implicitly (and wrongly) assumes that the entire firms' activities are regulated. Consequently, I do not favour this approach. Averaging the risk free rate over some historical period is subject to a number of problems, involving overestimating the cost of equity for businesses with equity betas less than 1, wrongly assuming that the widely employed MRP estimate of 6% is an estimate of the long-term average MRP, ambiguity over the 'correct' averaging period for the risk free rate, the unsubstantiated belief that variations in the MRP and the risk free rate are largely offsetting, the sacrifice of an observable, relevant and significant parameter, and potential spillover effects on the estimated cost of debt. I think these problems are sufficiently pronounced that this methodology should not be employed. By contrast, using the DGM to estimate the MRP is worthy of consideration but as a complement to rather than a substitute for the AER's current approach. Furthermore, amongst its many drawbacks is the likelihood that it would currently overestimate the MRP due to assuming that future costs of equity are the same for all future years.

The third question is whether CEG's MRP estimate of 8.52% from the AMP variant on the DGM approach is a reasonable estimate. I identify two significant errors in this approach and the net effect of them is to overestimate the MRP by about 1%. This is in addition to the overestimation referred to in the previous paragraph.

The fourth question involves critically reviewing the AER's belief that its current approach involves using the current ten-year risk free rate and an estimate of the MRP over the next ten years, along with Aurora's view that the AER's MRP is for a much longer and therefore inconsistent period. I concur with the AER's position. The fact that the AER bases its MRP estimate at least partly upon historical averaging of excess returns does not invalidate its claim that it is estimating the MRP for the next ten years; this estimation methodology is suitable (in conjunction with other methodologies) for estimating the MRP for the next ten years as well as for estimating the long-term average MRP. Furthermore, the use of historical averaging results *may* introduce a downward bias at the present time, but the effect is likely to be small relative to the standard deviation in the estimate and to possible upward bias in the methodology arising from significant unanticipated inflation in the 20th century.

The fifth question is whether the AER's use of the current ten-year CGS yield, along with an estimate for the MRP for the next ten years that has not changed as the ten-year CGS yield has recently declined, is reasonable in view of realised returns from other assets of comparable risk, expected returns for the same assets, and opportunity cost considerations. Realised returns are not relevant here and opportunity cost is synonymous with the expected return from assets of comparable risk. The expected returns on these assets are also reduced by the recent decline in the ten-year CGS yield and therefore the only remaining issue is whether the MRP for the next ten years has risen in the last year to counteract the fall in the ten-year CGS yield. This is CEG's argument, but the evidence they present in support of it is not convincing.

The final question is whether the AER's current methodology is appropriate in current market conditions. I concur with the AER's current approach to estimating the cost of capital in coupling an estimate of the forward-looking MRP with the current risk free rate. However, whilst the AER uses the current ten-year risk free rate within the first term of the CAPM, I favour the rate whose term matches the regulatory cycle to ensure that the present value of the regulated entity's future cash flows matches its initial investment. In addition, whilst the

AER gives primary weight to historical averaging of excess returns and survey results in estimating the forward-looking MRP, I consider that the AER should give consideration or additional weight to a number of other methods including the Siegel approach, the DGM, and results from a range of other markets. In addition, if historical average returns are used, they should be arithmetic rather than geometric averages.

1. Introduction

This paper seeks to address a number of questions posed by the AER, as follows.

Firstly, critically evaluate the theoretical and empirical evidence presented by CEG (2012) in support of the following contentions:

(a) That CGS yields are falling primarily as a consequence of factors that do not push down the overall cost of equity.
(b) That there is a clear negative relationship between the ten year CGS yield and the ten year forward-looking MRP.
(c) That the cost of equity is stable over time.

Secondly, critically evaluate the three approaches to estimating the cost of equity proposed by CEG. These are

(a) Estimating the cost of equity directly using DGM estimates.
(b) Estimating the risk free rate based on the prevailing ten year CGS yield and estimating the MRP based on prevailing DGM estimates.
(c) Estimating the risk free rate based on a historical average CGS yield and estimating the MRP based on historical excess returns.

Thirdly, in relation to CEG's estimate of 8.52% for the MRP based on what it describes as the 'AMP method', critically evaluate this particular DGM methodology and the input assumptions adopted by CEG.

Fourthly, in relation to the Aurora final decision (AER, 2012, Attachments, pp. 128-131, 136) in which the AER rejected Aurora's argument that the AER had estimated a 'short term' risk free rate and a 'long term' MRP, which Aurora (2012) argued was internally inconsistent, and the AER instead contended that it had estimated a ten year forward-looking risk free rate and a ten year forward-looking MRP, critically evaluate the AER's position on this matter.

Fifthly, given that the AER's current approach to determining the cost of equity is based on the prevailing ten year CGS yield plus 6% (MRP) multiplied by 0.8 (equity beta), which has led to a lower calculated cost of equity for regulated utilities as the ten year CGS yield has decreased over the past year, critically evaluate the reasonableness of this outcome taking into account:

(a) An opportunity cost perspective on the cost of capital, and
(b) The realised and expected returns from alternative risky investment opportunities in current market circumstances.

Sixthly, critically evaluate whether the AER's current approach to determining the cost of equity is appropriate in current market conditions and, if the AER's current approach is not appropriate in current market conditions, recommend the best alternative value or methodology for the risk free rate and the MRP.

2. The Relationship between the Risk Free Rate and the MRP

CEG (2012, sections 2-5) argues that variations in the ten-year CGS yield are strongly negatively related to variations in the ten-year MRP, to the extent that the ten-year cost of equity is largely unchanged. Consequently, the currently low value for the ten-year CGS yield does not warrant a lower cost of equity for regulated firms.

Although there is nothing in finance theory that supports (or rejects) a negative relationship between the CGS rate and the MRP, a negative relationship is plausible because the market risk premium is compensation for bearing equity risk (Merton, 1980), equity risk (volatility) seems to be greatest in depressed economic conditions (French et al, 1987, Figure 1a), and the risk free rate also tends to be lowest in depressed economic conditions. However, whilst CGS yields are very low because of generally depressed world economic conditions, Australia is not experiencing depressed economic conditions. Furthermore, even if the correlation between the CGS yield and the MRP were negative, the significant issue for regulatory purposes is the *strength* of this relationship and especially its strength in respect of the ten year risk free rate and the ten year MRP. Market volatility (and therefore the market risk premium) might be high today but volatility (and hence the MRP) tends to rapidly subside to normal levels (French et al, 1987, Figure 1a) and the MRP for the next ten years might not then be greatly increased by a temporary upsurge in volatility.

CEG presents some evidence in support of their argument that the risk free rate and the MRP are strongly negatively related, as follows. Firstly, CEG (2012, paras 42-43) cite Lettau and

Ludvigson (2001) in claiming that "when the de-trended risk free rate fell the (market) risk premiums tended to rise by the same amount". However CEG does not identify any particular section of the Lettau and Ludvigson paper that supports this specific assertion. Furthermore, the risk free rate used by Lettau and Ludvigson is the US 30-day Treasury Bill rate (ibid, page 825) rather than the ten-year rate and the "risk premiums" referred to only changed in the opposite direction to that of the Treasury Bill rate over the following two years, after which they moved in the reverse direction (ibid, Table VI). Furthermore, these "risk premiums" are in fact actual returns, and therefore the relationship uncovered may simply reflect market inefficiency rather than changes in risk premiums, i.e., the increases in equity returns subsequent to low risk free rates may reflect market undervaluation of equities at the time of the low risk free rates (when economic conditions are adverse). So, the Lettau and Ludvigson paper does *not* support the claim that a fall in the ten year risk free rate will be followed by a rise in the ten year MRP, let alone a rise of compensating magnitude.

Secondly, CEG (2012, para 44) cites Smithers and Co (2003, page 49) in support of the claim that the (nominal) risk free rate moves inversely with the (nominal) MRP. In turn Smithers and Co reach this view based upon the observation that the real return on US stocks over the last 100-200 years has been much more stable than the real risk free rate, and they refer to this as "Siegel's Constant" (ibid, pp. 31-38). This view presumably comes from Siegel (1992, 1999), who claims that the real return on equities is *more* stable than that on long-term government bonds, that this is due to significant unexpected inflation during the 20th century, that historical average excess returns from 1926 overestimate the true MRP during that period, and that the MRP in the future will therefore be significantly less than that estimated by historical average excess returns using data from 1926. However, Siegel's arguments are concerned with real rather than nominal returns. Furthermore, even in respect of real returns, Siegel does *not* argue that the MRP moves inversely with the risk free rate to the point that the cost of equity is largely unchanged.

Thirdly, CEG (2012, paras 46-63) describes the general increase in debt risk premiums on non-CGS bonds contemporaneous with the recent decline in the risk free rate, which is uncontroversial, and claims that "standard finance theory" would support an increase in the MRP of at least that in debt risk premiums. Subsequently, CEG (2012, para 96) explain this with an example involving Victorian government debt, for which the debt risk premium increased from 0.51% in 2011 to 0.80% in 2012. Assuming an MRP of 6.0% in 2011, CEG claim that the debt risk premium in 2011 of 0.51% implies a debt beta of 0.09, and coupling the same debt beta with the 2012 debt risk premium of 0.80% implies a 2012 MRP of 9.0%. However, these results are only true if the cost of debt is both an expected rate of return and the margin over the risk free rate is compensation for only systematic risk, and both conditions are false. In particular, the cost of debt is a promised rate of return and this exceeds the expected rate of return by the expected default losses (*DF*). Furthermore, the expected rate of return on state government debt is likely to incorporate an allowance for inferior liquidity relative to CGS (*LIQ*). Thus the debt risk premium (*DRP*) can be expressed as

$$DRP = MRP\beta_d + DF + LIQ$$

where β_d is the debt beta. Accordingly, the rise in the debt risk premium on Victorian government debt from 0.51% in 2011 to 0.80% in 2012 may have been due entirely to increases in *DF* and *LIQ*, in which case one cannot conclude that the MRP rose. Remarkably, CEG (2012, para 55) refer to the rise in the debt risk premium for state government debt and attribute this to a "heightened safety/liquidity/scarcity premium for CGS", which seems to involve acknowledging that *DF* and *LIQ* might have risen. Thus, the evidence presented by CEG for a rise in the MRP is not compelling, there are credible alternative explanations, and even CEG elsewhere acknowledge these alternative explanations.

Fourthly, CEG (2012, paras 67-71) generates a time-series of estimates of the market cost of equity over the last 20 years, as shown in their Figure 8, and argue that the stability in this time series in the face of considerable variation in the ten-year risk free rate implies that the MRP changes in an approximately offsetting fashion to the ten year risk free rate. However, in estimating this cost of equity by matching the present value of future dividends to their current market value, CEG assumes that at any point in time the market cost of equity is the same for all future years. Thus, if the current ten year risk free rate were unusually low relative to its long-term average (as is clearly the case), CEG implicitly believes that the MRP over the next ten years would be unusually high (relative to its long-term average) by an exactly offsetting amount. With this 'perfect-offset' assumption, CEG then generate results showing the stability of the cost of equity over time. However the 'perfect-offset' assumption necessarily leads to greater stability over time in the estimated cost of equity than would otherwise arise. Consequently this critical piece of evidence is prejudiced in favour of the result that is found.

To illustrate the point that the 'perfect-offset' assumption dramatically dampens variation over time in the estimated market cost of equity, suppose the market dividends in the most recent year are denoted *D* and, at any point in time, are expected to grow at 5% per year in perpetuity. Suppose further that the long-run average for the ten-year risk free rate is 5% and any deviations from this give rise to the expectation of a reversion back to 5%. Suppose further that the MRP does not vary from 6%, so that any variations in the risk free rate from its long-run average do not induce countervailing changes in the MRP. Suppose further that the current ten-year risk free rate is unusually high at 7%, and it is expected to revert to 5% in ten years' time. The current market cost of equity is then 13% and is expected to revert to 11% in ten years' time. Accordingly the market value of equities will be as follows:

$$S = \frac{D(1.05)}{1.13} + ... + \frac{D(1.05)^{10}}{(1.13)^{10}} + \frac{E(S_{10})}{(1.13)^{10}}$$

$$= \frac{D(1.05)}{.13-.05}\left[1-\left(\frac{1.05}{1.13}\right)^{10}\right] + \frac{\left[\frac{D(1.05)^{11}}{.11-.05}\right]}{(1.13)^{10}}$$

Per \$1 of *D* this is \$15.22. By contrast, the process used by CEG to estimate the market cost of equity over the next ten years (k) assumes that all future values of k are equal:

$$S = \frac{\$1(1.05)}{1+k} + \frac{\$1(1.05)^2}{(1+k)^2} + ... = \frac{\$1(1.05)}{k-.05}$$

Substituting S = \$15.22 into the last equation, the resulting estimate for k is 11.9%, and this is below the true value of 13% because CEG assume k is the same for all future years. The process is now repeated with a current ten-year risk free rate of 3%, which is expected to revert to 5% in ten years. So, with an MRP of 6%, the current market cost of equity is 9%, which is expected to revert to 11% in ten years. Following the same process as above, CEG's approach would then estimate the current market cost of equity at 10.2%. Thus the true current market cost of equity has varied from 9% to 13% whilst the estimate of it using

CEG's methodology has varied from only 10.2% to 11.9% despite the fact that the MRP has not changed as the risk free rate has changed. So, if one observes little variation over time in the cost of equity estimated through CEG's approach, one cannot conclude that the MRP moves inversely with the risk free rate; most of the explanation for the stability in the estimated cost of equity arises from the assumption that, at any point in time, the cost of equity is the same for all future years.

In summary, CEG do not present any persuasive evidence that there is a *strong* negative relationship between the ten year risk free rate and the MRP, and the primary evidence they do present in their Figure 8 is pre-disposed to that result.

3. CEG's Proposed Approaches to Estimating the Cost of Equity

3.1 Firm-Level DGM

CEG (2012, section 7) presents three possible approaches to estimating the cost of equity, and these are now examined. The first of these approaches is the DGM applied to each of six Australian regulated businesses, which estimates the cost of equity consistent with the current share price, the current dividend level, and estimates of future expected dividends per share. For each company, CEG estimates the future expected dividends per share using Bloomberg forecasts for the first two years followed by a long-run growth rate of either 2.5% (expected future inflation) or 6.6% (expected future GDP growth rate). Across the six companies the average cost of equity varies from 10.87% to 14.59% according to whether the expected dividend growth rate is 2.5% or 6.6% respectively (CEG, 2012, section 4.4).

This methodology has the advantage of reflecting current market conditions but is subject to a number of difficulties. CEG (2012, para 155) refers to the possible lack of credible short-term dividend forecasts. However there are more serious concerns. Firstly, at a given point in time, the estimated cost of equity for a company is assumed to be the same for all future years. Thus, if the current ten year risk free rate were unusually *low* relative to its long-term average (as is the case) and therefore could be expected to be higher in ten years' time, this methodology implicitly assumes that the equity risk premium for the company over the next ten years would be unusually *high* relative to its long-term average by an exactly offsetting amount. This 'perfect-offset hypothesis' is implausible and, since the current risk free rate is unusually low, will overestimate of the cost of equity for the next ten years.[1] To illustrate this point, suppose that the current ten year risk free rate is 3.8%, the company's equity risk premium over the next ten years is 6.2% and therefore the current cost of equity over the next ten years is 10%. Since the risk free rate is unusually low, the rate expected in ten years should be higher and we assume it equals its long-term average of (for example) 6%. In addition, since the risk free rate is expected to rise, the company's equity risk premium might be expected to fall, and we therefore assume it is expected to fall to its long-term average of (for example) 6%. In addition, the expected growth rate in dividends is 5% per year in perpetuity. It follows that the current share price of the company (*P*) is as follows:

$$P = \frac{D(1.05)}{1.10} + ... + \frac{D(1.05)^{10}}{(1.10)^{10}} + \frac{E(S_{10})}{(1.10)^{10}}$$

$$= \frac{D(1.05)}{.10-.05}\left[1-\left(\frac{1.05}{1.10}\right)^{10}\right] + \frac{\left[\frac{D(1.05)^{11}}{.12-.05}\right]}{(1.10)^{10}}$$

where *D* is the dividends per share in the most recent year. Per \$1 of *D*, the current share price is then \$17.23. By contrast, the DGM assumes the same cost of equity *k* for all future years. Consequently, with *P* = \$17.23, the DGM would estimate the company's cost of equity *k* as the solution to the following equation:

$$\$17.23 = \frac{\$1(1.05)}{1+k} + \frac{\$1(1.05)^2}{(1+k)^2} + ... = \frac{\$1(1.05)}{k-.05} \qquad (1)$$

Solving this equation yields an estimate for *k* of 11.1%, which is assumed to hold for all future years. This is 1.1% above the actual cost of equity for the first ten years of 10%, and the error arises from assuming the same cost of equity for all future years when the rate actually differs over future years.

Secondly, this methodology assumes that the current share price of the company matches the present value of future dividends per share. Consequently, if the current share price exceeds the present value of future dividends, then the estimate for the cost of equity that arises from

[1] Evidence of its implausibility will be discussed in the next section.

this methodology will be too low.[2] Similarly, if the current share price is below the present value of future dividends, then the estimate for the cost of equity that arises from this methodology will be too high. To illustrate the possible extent of the errors, suppose that the current share price of the company is 25% below the present value of future dividends. This would reduce the left-hand side of equation (1) by 25%, and solving for k in this new situation would then yield an estimate of 13.1%. This contrasts with the estimate of 11.1% if the current share price of the company matched the present value of future dividends, and therefore the cost of equity would be overestimated by 2.1% as a result of this point (as well as a further 1.1% as a result of the previous point).

Thirdly, the DGM methodology is error-prone in the presence of fluctuations in the firm's earnings retention rate. For example, consider a firm with a cost of equity of 10% per year in perpetuity, a current annualised dividend level of \$1 per share, and an expected growth rate in dividends per share of 5% per year in perpetuity (arising from the Bloomberg forecasts for the next two years and the expected long-run GDP growth rate). The share price P would then be as follows:

$$P = \frac{\$1(1.05)}{1.10} + \frac{\$1(1.05)^2}{(1.10)^2} + ... = \frac{\$1(1.05)}{.10 - .05} = \$21$$

Application of the DGM methodology would then accurately estimate the firm's cost of equity at 10%, by solving the following equation:

$$\$21 = \frac{\$1(1.05)}{1+k} + \frac{\$1(1.05)^2}{(1+k)^2} + ... = \frac{\$1(1.05)}{k - .05}$$

Now suppose instead that the firm decides to reduce its retention (and hence investment) level over the next five years, and that the effect of this will be to raise its expected dividends per share (relative to the above path) to \$1.60 for each of the next five years, followed by subsequent reductions in expected dividends per share (relative to the above path). Suppose also that the cancelled investments are NPV neutral. Since the investments are NPV neutral, the share price of \$21 would not be affected by this new policy. In addition the expected long-run GDP growth rate would still be 5%. However the Bloomberg dividend forecasts for

[2] Smithers and Co (2003, page 49) make this same point. CEG (2012, para 44) cite them in support of a different point (on the same page) whilst ignoring their concern about the DGM.

the next two years would now be \$1.60 for each year. So, application of the DGM with Bloomberg's dividend forecasts for the next two years followed by a long-run expected growth rate of 5% would yield the following

$$\$21 = \frac{\$1.60}{1+k} + \frac{\$1.60}{(1+k)^2} + \frac{\$1.60}{(1+k)^3} + \frac{\$1.60(1.05)}{(1+k)^4} + \ldots\ldots$$

Solving this equation yields an estimate for k of 12%, which is 2% above the correct value of 10%. So the DGM methodology coupled with Bloomberg's dividend forecasts for the next two years followed by a long-run expected growth rate in GDP could produce very significant errors in estimating the firm's cost of equity. The source of the problem is the fact that the dividends per share of \$1.60 arise from a *temporary* reduction in the firm's retention rate and therefore are not a suitable base from which to project subsequent dividends per share.

An alternative scenario of this general type would involve the firm paying dividends in excess of its free cash flow and borrowing to meet the cash flow shortfall. If the borrowing required here were sufficiently large to progressively raise the firm's leverage ratio, then such a strategy would not be indefinitely sustainable, and therefore dividends will fall at some point. This scenario characterises a number of UK water utilities (Armitage, 2012). The DGM methodology would not allow for the future dividend reduction and would therefore again overestimate the firm's cost of equity.

Fourthly, and consequent upon the previous point, if this DGM approach were used to estimate the cost of equity for regulated firms, the firms in question would have a very strong incentive to manipulate their retention rates for the purpose of increasing their estimated cost of equity and therefore the cost of capital allowed by a regulator.

Fifthly, the methodology produces an estimated cost of equity for the company and therefore will not accurately estimate the cost of equity of the regulated activities of the company if they represent only part of its activities. Furthermore, since non-regulated activities tend to have higher risk, the estimated cost of equity for the company will tend to overestimate that for its regulated activities, and the AER (2012, Attachments, pp. 159-161) notes that the six companies analysed by CEG have unregulated activities.

3.2 Market-Level DGM

The second approach considered by CEG is to use the DGM model to estimate the cost of equity for the market in aggregate. The prevailing ten-year risk free rate is then deducted from this to yield the estimated MRP. This estimate is then substituted into the CAPM in the usual way, along with the prevailing risk free rate and the estimated equity beta, to produce an estimate for the cost of equity for a regulated business.

This methodology has the advantage of reflecting current market conditions but is subject to a number of difficulties. Firstly, the cost of equity for the market is assumed to be the same for all future years. Thus, if the current ten year risk free rate were unusually high relative to its long-term average, and therefore could be expected to be lower in ten years' time, this methodology implicitly assumes that the MRP over the next ten will be unusually low relative to its long-term average by an exactly offsetting amount. This 'perfect-offset' hypothesis is implausible, and even stronger than CEG's explicitly stated view that risk free rates and MRPs are negatively (but imperfectly) correlated. It is also testable using the time-series of risk free rates coupled with CEG's estimates of the MRP that are based on the 'perfect-offset' hypothesis (CEG, 2012, Figure 8). Figure 8 shows that, in 1994, CEG's estimate of the market cost of equity was about 10.5%, matching the contemporaneous (and unusually high) ten year risk free rate, and therefore implying an MRP of zero. Clearly, an estimate for the MRP of zero is implausible and it suggests that CEG's belief that, at any point in time, the market cost of equity over the next ten years will match the expected rate thereafter can be rejected. The much more plausible hypothesis is that, in 1994, the market cost of equity over the following ten years was larger than over subsequent years and therefore larger than CEG's estimate of 10.5%. Accordingly, in 1994, the MRP over the following ten years was positive rather than zero. Thus, if the perfect-offset hypothesis should be rejected in 1994 when the risk free rate was unusually high, it should also be rejected in 2012 when the risk free rate was unusually low. So, in 2012, the market cost of equity over the following ten years would be less than over subsequent years, and therefore less than CEG's estimate. Accordingly, the estimated MRP over the next ten years is less than CEG's estimate.

To illustrate CEG's overestimation of the MRP for the next ten years, suppose that the current ten year risk free rate is 3.8%, the MRP over the next ten years is 6.2% and therefore the current cost of equity over the next ten years is 10%. Since the risk free rate is so low, the rate expected in ten years should be higher and we assume it equals the long-term average of (for example) 6%. In addition, since the risk free rate is expected to rise, the MRP might be expected to fall, and we therefore assume it is expected to fall to its long-term average of (for example) 6%. In addition, we assume an expected long-run growth rate in dividends of 5%. Letting *D* denote the dividends in the most recent year, it follows that the current value of equities is as follows:

$$S = \frac{D(1.05)}{1.10} + ... + \frac{D(1.05)^{10}}{(1.10)^{10}} + \frac{E(S_{10})}{(1.10)^{10}}$$

$$= \frac{D(1.05)}{.10-.05}\left[1-\left(\frac{1.05}{1.10}\right)^{10}\right] + \frac{\left[\frac{D(1.05)^{11}}{.12-.05}\right]}{(1.10)^{10}}$$

Per \$1 of current dividends *D*, the current equity value is then \$17.23. By contrast, if one assumed a constant value for the market cost of equity capital *k* (along with a constant growth rate *g*) then the estimate of *k* would satisfy the following equation:

$$S = \frac{D(1+g)}{1+k} + \frac{D(1+g)^2}{(1+k)^2} + ... = \frac{D(1+g)}{k-g}$$

Solving this equation for *k* then yields

$$k = \frac{D}{S}(1+g) + g \qquad (2)$$

Substituting the equity value of \$17.23 above (per \$1 of current dividends) into the DGM equation (2) along with the expected growth rate of 5% yields an estimated cost of equity of 11.1%. Deduction of the current risk free rate of 3.8% then yields an estimated MRP of 7.3%. This is 1.1% above the actual MRP of 6.2% for the first ten years, and the error arises from assuming the same cost of equity for all future years when the rate actually differs over future years.

Secondly, this methodology assumes that the current value of equities matches the present value of future dividends. Consequently, if the current value of equities exceeds the present value of future dividends, then the estimate for the market cost of equity (and hence the MRP) that arises from this methodology will be too low. Similarly, if the current value of equities is below the present value of future dividends, then the estimate for the market cost of equity (and hence the MRP) that arises from this methodology will be too high. To illustrate the possible extent of the errors, suppose that the current value of equities is 25% below the present value of future dividends. In addition, consistent with CEG, suppose that the expected growth rate in dividends is 6.60%, the current dividend yield is 5.68%, and the current ten year risk free rate is 3.77%. These parameters in conjunction with equation (2) imply that the MRP is estimated at 8.89%. However, if the current value of equities matched the present value of future dividends rather than being 25% below it, the estimate of the MRP would have been 7.37%, and therefore it would have been overestimated by 1.52% as a result of the market valuation error.

Thirdly, the DGM methodology is error-prone in the presence of short-term fluctuations in the market's earnings retention rate. For example, suppose the market cost of equity is 10% per year in perpetuity, the expected growth rate in dividends per share is 5% per year in perpetuity (matching the expected long-run expected GDP growth rate), and the dividends in the most recent year were $1b. Suppose also that the risk free rate is 4% in perpetuity, and therefore the MRP is 6%. Using the first three of these parameters, the current value of equities would then be as follows:

$$S = \frac{\$1b(1.05)}{1.10} + \frac{\$1b(1.05)^2}{(1.10)^2} + ... = \frac{\$1b(1.05)}{.10 - .05} = \$21b$$

Substitution of this value for *S*, along with the current dividend level *D* and the expected growth rate in dividends *g*, into the DGM equation (2) would then accurately estimate the market cost of equity at 10%, and deduction of the risk free rate of 4% would then yield an accurate estimate of the MRP. Now suppose instead that firms in aggregate lowered their earnings retention rate in the most recent year and that the effect of this was to raise the current dividend level from $1b to $1.3b, at the expense of future dividends (relative to the above path). Suppose also that the effect of this change was NPV neutral, so that the current value of equities would be lower by \$0.3b. So, application of the DGM in equation (2) with *g* still estimated from the expected long-run growth rate in GDP (at 5%) would yield the following estimate of the market cost of equity:

$$k = \frac{\$1.3b}{\$20.7b}(1.05) + .05 = .116$$

Deduction of the risk free rate of 4% would then yield an estimate of the MRP of 7.6%. Since the true MRP is 6%, the DGM has overestimated it by 1.6%. The source of the problem is the fact that the higher current dividends of \$1.3b arise from a temporary reduction in firms' retention rates and therefore are not a suitable base from which to project subsequent dividends.

Fourthly, the DGM combines the current dividend level of firms (which reflects the current earnings retention rate) with an expected long-run growth rate in dividends per share for existing companies that is based upon an estimate of the expected long-run growth rate in GDP, and the latter estimate is based upon historical averaging and therefore upon the historical average earnings retention rate (assuming plausibly that the growth rate in GDP is affected by the level of corporate investment). Thus, if the earnings retention rate has fallen over time, so that the current level is below its historical average, then estimating the expected long-run growth rate in GDP from its historical average will over estimate this parameter and therefore overestimate the MRP.

3.3 Market-Level DGM with the AMP Method

In using the Market-level DGM approach, CEG adopt a particular variant that they term the AMP Method. This involves adding the dividend yield of 5.68% to the expected long-run growth rate in dividends of 6.6% to yield an estimated market cost of equity capital of 12.28%, and the expected long-run growth rate in dividends is set equal to the expected long-run growth rate in GDP (CEG, 2012, Table 4 and section 4.3). The prevailing ten-year risk free rate of 3.77% is then deducted from this cost of equity to yield the estimated MRP of 8.52%. This estimate is then substituted into the CAPM in the usual way, along with the prevailing risk free rate of 3.77% and the estimated equity beta of 0.8, to produce an estimate of the cost of equity for a regulated business.

This particular variant of the DGM has two defects. Firstly, CEG clearly intend that the expected growth rate in dividends of 6.60% applies immediately and therefore the value of equites (S) can be represented as follows:

$$S = \frac{D(1+g)}{1+k} + \frac{D(1+g)^2}{(1+k)^2} + ... = \frac{D(1+g)}{k-g}$$

where D is the dividends in the most recent year, g is the expected growth rate, and k is the market cost of equity capital. Solving this equation for k then yields

$$k = \frac{D}{S}(1+g) + g \qquad (3)$$

Substituting CEG's parameter values into equation (3) then yields a value for k of 12.65%, and deduction of the risk free rate of 3.77% then yields an estimate for the market risk premium of 8.89% rather than the figure of 8.52% claimed by CEG. CEG's error was to ignore the (1+g) term in equation (3).

Secondly, the AMP Method sets the expected growth rate for dividends equal to the long-term expected GDP growth rate. However, the long-term expected growth rate for dividends in the DGM model is that for dividends per share in existing companies, and this must be less than that for GDP. If these two growth rates matched then, since the expected long-term growth rate in all dividends from all companies exceeds that for dividends per share in existing companies (due to new share issues net of buybacks and also to the formation of new companies), the expected long-term growth rate in all dividends from all companies would exceed that for GDP, and therefore dividends in absolute terms would eventually exceed GDP in absolute terms. This is impossible. So, it would be more reasonable to assume that the long-term growth rate in dividends for all companies will match that for GDP (to ensure that the ratio of dividends to GDP does not eventually reach zero or exceed 1). It follows that the expected long-term growth rate in dividends per share for existing companies will be less than that for GDP, to reflect the impact of new share issues (net of buybacks) and the formation of new companies. Bernstein and Arnott (2003) argue for subtracting 2% to deal with both of these points, based upon two comparisons. The first comparison is of real growth in dividends per share with real GDP growth over the last century, for a range of countries; the latter grew about 2% per annum faster than the former (ibid, Table 1). However this comparison will exaggerate the relevant adjustment in the presence of a declining dividend payout rate, which has characterised at least the US market. Their second comparison is of the growth in market capitalisation with the growth in a capitalisation-weighted price index, using US data since 1925; the former grew about 2% per annum faster than the latter. However, this comparison will exaggerate the relevant adjustment when market capitalisation grows simply due to listings from foreign firms and from previously unlisted US firms. Both points suggest that the correct adjustment is less than 2%. If we deduct 1% from the expected long-term growth rate in GDP, the estimate for the expected long-term growth rate in dividends would then be 5.6%, and substitution of this into equation (3) followed by deduction of the risk free rate would yield an estimated MRP of 7.82% rather than 8.89%. If the deduction is instead 1.5%, to yield an expected long-run growth rate in dividends of 5.1%, then the estimated MRP would fall further to 7.3%.

In summary, I identify two errors in the AMP model, whose net effect is to overestimate the MRP by about 1%. This overestimation is in addition to any overestimates identified in section 3.2.

3.4 Long-Term Averaging

The third approach considered by CEG is to invoke the CAPM along with an estimate of the long-term average MRP (6%) and an estimate of the long-term average risk free rate of 5.99%, with the latter based upon averaging results over the entire period since the RBA adopted inflation-targeting (June 1993).[3] Although neither of these average parameter values would necessarily match their current values, CEG argues that variations across time are largely offsetting and therefore the resulting cost of equity from this proposed approach is more reliable than the generally employed methodology amongst Australian regulators, involving the current risk free rate and an estimate of the long-term average MRP of 6%.

This proposal is subject to a number of difficulties, as follows. Firstly, even if all CEG's claims about this approach were true, it would only produce an accurate estimate for the cost of equity for a company with a beta of 1. For businesses with equity betas less than 1, CEG's

[3] CEG refers to "historical average", "long-term average", and "normal" rates within its report. I interpret them to be concerned with average rates over an indefinitely long period, well in excess of the ten year period to which the AER's MRP estimate relates, and for which historical averages are merely intended to estimate.

approach will overestimate the cost of equity because the overestimate in the risk free rate will exceed the underestimate of the risk premium.

Secondly, the approach assumes that the estimate for the MRP of 6% is an estimate of the long-term average market risk premium. However, in respect of some Australian regulators, this belief is not correct. For example, the AER (2012, pp. 128-136) bases its estimate of 6% upon both historical average excess returns and forward-looking evidence such as surveys whilst the QCA (2011, pp. 238-240) bases its estimate of 6% upon the results from four different methodologies and only two of these involve long-run historical data with the other two being forward-looking methods. Thus, even if one viewed the reliance upon long-run historical data by both regulators as an attempt to estimate the long-term average market risk premium, it cannot be said that their estimates of the market risk premium are entirely of this kind.

Thirdly, CEG's proposed methodology requires a judgement about the historical period over which to average the risk free rate and different judgements will produce different results. CEG propose using the period from June 1993, when the RBA adopted inflation targeting (of 2-3%). However the CGS yields in the first five years after this were high by comparison with subsequent rates; in particular, they reached 11% in the first five years whereas they did not subsequently exceeded 7.3% even during the prolonged world-wide boom from 2002-2007 (CEG, 2012, Figure 8). A possible explanation is that there was considerable scepticism amongst investors within the first few years of inflation targeting that inflation would be constrained to 3% and the CGS yields gradually subsided as the RBA's credibility grew and scepticism subsided. If so, then the averaging should be done from about 1998 and the result would then be significantly lower. Furthermore it could be argued that even this period from about 1998 is over-represented by unusually good economic conditions and this imparts an upward bias to the resulting estimate of the long-run risk free rate. It is therefore not clear which historical period should be used for averaging the risk free rate, and therefore it is not clear what the result from this methodology should be.

Fourthly, CEG's proposed methodology rests on the belief that variations in the risk free rate and the market risk premium are largely offsetting over time, and the principal evidence offered by CEG in support of this claim is the relatively stable behaviour over time of the estimated market cost of equity (as shown in CEG's Figure 8). However, as noted earlier, the estimated costs of equity shown in Figure 8 are obtained by assuming that, at any point in time, the market cost of equity is the same for all future years, and this assumption produces a smoother time series in the estimated cost of equity than would otherwise be the case. Furthermore, as noted previously, this assumption underlying Figure 8 can be tested by observing that the model gives rise to an estimated market risk premium of zero in 1994; this outcome is not plausible and therefore suggests that the underlying assumption is not plausible.

Fifthly, CEG's proposed methodology sacrifices a relevant, critical and observable parameter within the cost of equity (the current risk free rate) in order to offset alleged errors in estimating another parameter (the market risk premium). However, the preceding four points above indicate that the benefits from this approach are exaggerated or nebulous. Thus, the proposed methodology involves a clear cost without a clear benefit and is therefore not recommended.

Sixthly, although CEG does not comment upon the cost of debt, their proposal to use the historical average risk free rate in the process of estimating the current ten-year cost of equity raises the question of whether the same historical average risk free rate would be used in the process of estimating the current ten-year cost of debt, and therefore whether the historical average debt risk premium would also be used in estimating the current ten-year cost of debt. CEG do not answer these questions but a regulated business that relies upon CEG's proposal to estimate the cost of equity does answer these questions, and favours using the historical average risk free rate along with the current debt risk premium to estimate the current ten-year cost of debt (Aurora, 2012). This is pure cherry-picking, and leads to overestimation of the current ten-year cost of debt. For example, suppose the current ten-year risk free rate is 3.8%, the current ten-year debt risk premium is 3.6%, the historical average ten-year risk free rate is 6.0%, and the historical average ten-year debt risk premium is 2.0%. The current ten-year cost of debt would then be 7.4% but Aurora would have overestimated it at 9.6% by combining the higher of the two risk free rates (the historical average of 6.0%) along with the higher of the two debt risk premiums (the current premium of 3.6%). Even if Aurora had used both the historical average risk free rate (6.0%) and the historical average debt risk premium (2.0%), they would have overestimated the current ten-year debt risk premium at 8.0%. The appropriate parameters to use in estimating the current cost of debt are the current risk free rate and the current debt risk premium, because the former is observable and the latter can be estimated with a high degree of precision. Any argument in favour of using a historical average risk free rate in estimating the cost of *equity*, because the MRP is difficult to estimate, has no relevance to estimating the cost of debt.

3.5 Evaluation of CEG's Proposals

CEG's first proposal, being the DGM approach to estimating an individual firm's cost of equity, is very similar to the DGM for estimating the market risk premium, but has the additional problems of greater exposure to fluctuations in the earnings payout rate, incentives for the firms in question to manipulate their earnings payout rate, and implicitly (and wrongly) assumes that the entire firm's activities are regulated. Consequently, I do not favour this approach.

CEG's third approach, involving substitution of the average risk free rate over some historical period for the current rate, is subject to a number of problems; these involve overestimating the cost of equity for businesses with equity betas less than 1, wrongly assuming that the widely employed MRP estimate of 6% is an estimate of the long-term average MRP, ambiguity over the 'correct' averaging period for the risk free rate, the unsubstantiated belief that variations in the MRP and the risk free rate are offsetting, sacrifice of an observable, relevant and significant parameter, and potential spillover problems in estimating the cost of debt. I think these problems are sufficiently pronounced that this methodology should not be employed.

This leaves CEG's second approach, involving using the DGM to estimate the MRP. Errors in the AMP variant rule this out of consideration, and their effect is to inflate the MRP estimate by about 1%. This point aside, the DGM is worthy of consideration but as a complement to rather than a substitute for other approaches.

4. The AER's Methodology and the Aurora Decision

In its recent Aurora Decision, the AER claims to be using the prevailing ten year risk free rate coupled with an estimate of the MRP for the next ten years, and that the latter estimate was primarily based upon both historical average excess returns and forward-looking evidence such as surveys (AER, 2012, Attachments, pp. 120-136). By contrast Aurora (2012, section 3.3) argued that the AER's approach involved combining a short-term risk free rate (for the next ten years) with a long-term MRP and that this was inconsistent. The AER's use of surveys to estimate the MRP over the next ten years is clearly not the source of Aurora's concern. So, prima facie, the 'problem', if there is one, arises in respect of the AER using historical average excess returns to estimate the MRP for the next ten years.

As one moves through time, both the true MRP for the next ten years and the estimate of it based upon historical average excess returns change. Plausibly, at some points in time, the historical average excess return may be biased up or down as an estimator of the true MRP for the next ten years. For example, if an economy has recently entered a major recession, the MRP for the next year may be unusually large and therefore the MRP for the next ten years is likely to be above normal (but much less so than over the next year because the premium over the next ten years only partly reflects anticipated conditions over the next year). In addition, a typical consequence of a recession is a significantly negative excess return on equities, and this will tend to generate a historical average excess return that is below normal. Thus, the historical average excess return may be below normal and the true MRP for the next ten years may be above normal, with the result that the historical average excess return may underestimate the true MRP for the next ten years. Clearly, Australia has not recently entered a major recession. However, even if it had, neither of these two bias effects is likely to be very large.

For example, suppose the true MRP for the next ten years is 6% immediately prior to the recession, the previous 100 years of excess returns generated a matching estimate of the MRP (of 6%), and the first year of the recession produced an excess return of -35%. In this case, after the first year of the recession, the new average excess return would be as follows:

$$\overline{R} = .06\left(\frac{100}{101}\right) - .35\left(\frac{1}{101}\right) = .056$$

In addition, suppose the recession raised the true MRP for the next year from 6% to 10% and this increment of 4% is expected to erode at the rate of 50% per year. The expected MRP over the next year would then be 8.0%, followed by 7.0%, etc. Averaged over the next ten years, the MRP would be 6.4%. Thus, the recession reduces the historic average excess return by 0.4% and simultaneously raises the true MRP for the next ten years by 0.4%, causing the historical average excess return to underestimate the MRP for the next ten years by 0.8%. This is not a very large figure.

In addition to bias in the historical average excess return as an estimator for the future MRP, some forward-looking estimators may be biased under the same recessionary conditions that historical average excess returns are. For example, consider the DGM methodology. As noted in sections 3.1 and 3.2, under a recessionary scenario, this methodology overestimates the cost of equity and the MRP over the next ten years by assuming (wrongly) that the cost of equity for the next ten years matches the rate over subsequent years. Highlighting biases in the historic average excess return methodology implies (wrongly) that it is the only methodology subject to such problems. Furthermore, any downward bias arising from the historical average excess return at the present time (as discussed above) may be less than the upward bias in this estimator arising from the significant unanticipated inflation in the 20th century (Siegel, 1992, 1999). Furthermore, even if all other methodologies were free of bias, it does not follow that the historical average excess return methodology should be avoided, and the rationale is as follows.

Firstly, in estimating the MRP for the next ten years, the goal should not be to choose an estimator (or combination of estimators) that is unbiased. Instead, a better goal would be to choose an estimator whose estimation errors were smallest, and the usual expression of this is minimising mean square error (MSE).[4] Letting $\hat{T}$ denote an estimator and T the true value, the MSE is as follows:

$$\begin{aligned} MSE &= E\left[\hat{T} - T\right]^2 \\ &= E\left[\hat{T} - E(\hat{T}) + E(\hat{T}) - T\right]^2 \\ &= E\left[\hat{T} - E(\hat{T})\right]^2 + \left[E(\hat{T}) - T\right]^2 \end{aligned} \qquad (4)$$

where the first term in the last equation is the variance of the estimator and the second term is the square of the bias. Suppose at the present time that the historical average excess return is biased down by 1% as an estimator of the MRP for the next ten years, and that its standard

[4] The MSE is the average over the squared differences between estimated value and the true value.

deviation is 2%.[5] Suppose also that a forward-looking estimator is unbiased, that it also has a standard deviation of 2%, and that the two estimators are uncorrelated. Using equation (4), the MSE of the historical average excess return is $.022^2$ and is therefore larger than that of the forward-looking estimator ($.02^2$). Consequently, if the choices were restricted to only one of these two estimators, the forward-looking estimator would be preferred. However, one could instead form a weighted-average of the two estimators with the weight on the first (*w*) chosen to minimise the MSE of the weighted-average, i.e., letting the two estimators be denoted 1 and 2, choose *w* to minimise

$$\begin{aligned} MSE &= E\left[w\hat{T}_1 + (1-w)\hat{T}_2 - T\right]^2 \\ &= E\left[w(\hat{T}_1 - T) + (1-w)(\hat{T}_2 - T)\right]^2 \\ &= w^2 E\left[\hat{T}_1 - T\right]^2 + (1-w)^2 E\left[\hat{T}_2 - T\right]^2 \\ &= w^2 MSE_1 + (1-w)^2 MSE_2 \end{aligned} \tag{5}$$

With MSE_1 and MSE_2 as given above, *MSE* is minimised with $w = .44$, i.e., a 44% weight on the historic average excess returns and therefore a 56% weight on the forward-looking estimator. So, even if the historic average excess return were significantly biased in estimating the MRP over the next ten years, it would still seem to warrant significant weight in a weighted-average estimator. This matches what the AER seems to be doing (AER, 2012, pp. 128-136).

Secondly, an even better goal than choosing an estimator with minimal MSE for the MRP over the next ten years would be to choose an estimator with minimal MSE for the MRP over the *life* of the regulated assets, i.e., under or over estimation within a single regulatory cycle would be of no great consequence relative to aggregate errors over the entire life of the regulated asset. With such a long period, short-term biases in the historic average excess return methodology are likely to wash out, and therefore the merits of historical averaging of excess returns will be even greater than previously concluded. Again, this matches what the AER seems to be doing.

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[5] The bias of 1% approximates the result of the analysis on the previous page, and the standard deviation of 2% is consistent with a standard deviation for annual Australian excess returns of 20% (Dimson et al, 2011, Table 13) coupled with the use of 100 years of annual excess returns.

In summary, the fact that the AER bases its estimate of the MRP at least partly upon historical averaging of excess returns does not invalidate its claim that it is estimating the MRP for the next ten years; this estimation methodology is suitable (in conjunction with other methodologies) for estimating the MRP for the next ten years as well as for estimating the long-term average MRP. The use of historical averaging results *may* introduce a downward bias at the present time, but the effect is likely to be small relative to the standard deviation in the estimate and to possible upward bias in the methodology arising from significant unanticipated inflation in the 20th century. Thus, I do not agree with Aurora's claim that the AER is combining a short-term risk free rate (next ten years) with an MRP for a much longer period.

5. The AER's Methodology under Current Conditions

The AER's current methodology for determining the cost of equity is to couple the current ten year CGS yield with an estimate of the MRP for the next ten years of 6% and an estimated equity beta of 0.8. As the ten year CGS yield has declined over the past year, but the AER's estimate of the MRP has not risen, the estimated cost of equity for regulated businesses has therefore also declined. This raises the question of whether such an outcome is reasonable in light of realised returns from other assets of comparable risk, expected returns for the same assets, and opportunity cost considerations.

In respect of realised returns, these are not relevant to a regulator. A regulator should set a price or revenue cap so that the regulated entity receives an expected rate of return that just compensates for systematic risk. If another business, with the same systematic risk and therefore the same expected rate of return, earns a higher realised rate of return through luck or actions that raise its revenues or reduce its costs, this does not provide grounds for an increase in the regulated firm's price or revenue cap.

In respect of opportunity cost, this is the same as the expected return from an asset of comparable risk. Finally, in respect of expected returns from other assets of comparable risk, the relevant risk is systematic. So, if these other assets have the same systematic risk, their expected return will be determined by the CGS yield and the MRP. Since the CGS yield has declined, this will exert the same downward effect upon their expected returns as it does on the expected returns allowed to the regulated businesses. The only possible source of divergence between their expected return and that granted to the regulated businesses lies in the MRP. If the MRP rose over the last year, this will exert an upward effect upon the expected returns of these other assets and therefore the expected returns granted to the regulated businesses will be inferior to those on these comparable assets. If the MRP did not rise over the last year, the regulated businesses will have received an expected rate of return that matched these other assets.

The fundamental issue then is one of whether the MRP has risen over the last year. This possibility cannot be ruled out, but persuasive evidence in support of the claim must be available. CEG's claims to this effect, as discussed above, are not persuasive.

6. Review of the AER's Methodology

The AER's current approach involves using the current ten-year risk free rate, an estimate of the MRP for the next ten years based primarily upon results from the historical averaging of excess returns and those from surveys, and recourse to both geometric and arithmetic means in the course of historical averaging (AER, 2012).

My views differ from this approach at three points. Firstly, in relation to the risk free rate used within the first term of the CAPM, I favour the rate whose term matches the regulatory cycle. This ensures that the present value of the regulated entity's future cash flows matches its initial investment (see Schmalensee, 1989; Lally, 2004, 2007).

The second point of difference concerns the methodologies used to estimate the forward-looking MRP. I think a wider set of methodologies for estimating the MRP should be considered or given greater weight by the AER, as follows. Historical averaging of excess returns (primarily from the 20th century) is subject to the plausible possibility that significant unanticipated inflation in the 20th century substantially lowered real risk free rates but not real equity returns, with the result that average excess returns from this period significantly overestimate the MRP during this period (Siegel, 1992, 1999).[6] Accordingly, one should estimate the MRP by adding back the historical average long-term real risk free rate to the

[6] Siegel's analysis is based on US data but the situation was even more dramatic in Australia. Dimson et al (2011, Table 14, Table 69) reports that the average real yield on long-term US government bonds was negative from 1940-1980 whilst it was negative on long-term Australian government bonds for the even longer period from 1940-1990.

conventional estimate and then deduct an improved estimate of the expected long-term real risk free rate. Results from this methodology have been used by both the QCA (2011, pp. 238-240) and the New Zealand Commerce Commission (2010) in reaching their conclusions about the MRP.

In addition, and notwithstanding the limitations of the DGM methodology identified in section 3.2, I consider that results from this approach should also be considered and given a higher weighting than the AER appears to have done. However, the errors in the AMP method identified in section 3.3 should be corrected. The DGM approach is a particularly useful complement to results from historical averaging because the two estimators would seem to be uncorrelated, and the lack of correlation implies that the weighted-average estimator that incorporates such results will have a significantly lower MSE than otherwise. To illustrate the latter point, consider two unbiased estimators with standard deviations of 2% each. If they are perfectly positively correlated then, regardless of the weights attached to them in a weighted-average estimator, the MSE of the weighted-average estimator will remain $.02^2$. However, if they are uncorrelated, equation (5) implies that the optimal weights will then be 50% each and the MSE will then fall to $.014^2$; this is a 50% reduction in the MSE.

McKenzie and Partington (2011, pp. 23-28) do not favour DGM methodologies because they consider that the range of results using 'reasonable' assumptions is too high. For example, in their Table 1, the MRP estimates from the DDM models (which are of the DGM type) range from 0% to 8%. However, I think this range can be narrowed. In relation to the higher MRP estimate of 8%, this arises from indefinitely extrapolating the short-run dividend growth rate forecasts of analysts. However these forecasts may exceed the expected long-run growth rate for GDP, subject to the adjustments identified by Bernstein and Arnott (2003), and therefore must converge on them, in which case the MRP estimate would be less. In relation to the lower MRP estimate of 0%, this arises by assuming that earnings per share under a zero retention policy do not grow in even nominal terms. However a minimum bound on earnings per share under zero retention would be the inflation rate and even this assumption would generate a higher MRP estimate than 0%. Of course, even with a narrowing in the range of MRP estimates, the band may still be substantial but historical averaging estimates are also problematic, with high standard deviations and possible significant upward bias (Siegel 1992, 199). The fact that all estimators are imprecise strengthens the case for significant weight on many of them.

In addition, results from other markets should also be considered. Results involving the historical-averaging of excess returns are available for 19 countries using data from 1900 from Dimson et al (2011). A possible concern here is that such results from foreign markets reflect the true MRPs in those markets and therefore use of such results will introduce bias. However, as discussed earlier, the focus should be on MSE rather than bias and combining an estimate based upon only Australian data with estimates from various foreign countries will yield a lower MSE than using only Australian data. Such estimators are well-established in the statistics literature (James and Stein, 1961; Efron and Morris, 1975; Efron, 2010). They have also been applied in finance to estimating betas (Vasicek, 1973), variances (Karolyi, 1993), and expected returns (Jorion, 1986; Grauer and Hakansson, 1995). More recently, they have also been applied to estimating MRPs (Lally and Randal, 2012) and they generate considerable reductions in MSE because virtually all of the cross-country variation in estimates appears to constitute estimation error rather than cross-country variation in true MRPs. An alternative approach using foreign data is to adjust MRP estimates from foreign markets for perceived differences from Australia such as risk and taxes (McKenzie and Partington, 2011, pp. 29-30). However such adjustments are inherently subjective.

To illustrate the MSE gains from using foreign data, suppose that an estimator using only Australian data is unbiased and has a standard deviation of 2% whilst an estimator using only US data has the same standard deviation, a bias of 1%, and is uncorrelated with the Australian estimator. Following equation (4), the MSE for the Australian estimator is $.02^2$ whilst that using US data is $.022^2$. Following equation (5), the MSE for a weighted-average of these estimators is minimised with a weight of 55% on the Australian estimator and therefore 45% on the estimator based upon US data. Further, with this weighted average, the MSE is $.015^2$, which is almost 50% less than for the estimator using only Australian data. Of course this example unrealistically assumes that the two individual estimators are uncorrelated, when in fact they would be positively correlated, and the effect of this is to reduce the benefits from a combined estimator. However, the Dimson et al (2011) data allows 18 rather than only one foreign country’s results to be used, and the effect of the additional markets more than outweighs the positive correlation effect. In particular, Lally and Randal (2012) find that the reduction in MSE is more than 50%.

The third point of difference between my views and the AER's methodology concerns the merits of geometric averaging. The AER's belief that geometric averages are useful apparently arises from a belief that there is a compounding effect in their regulatory process (AER, 2012, Appendix A.2.1), and therefore the analysis of Blume (1974) and Jacquier et al (2003) applies. However, I do not think that there is any such compounding effect in regulatory situations and the absence of a compounding effect leads to a preference for the arithmetic mean over the geometric mean. To demonstrate this point, suppose that a regulator sets a price cap over a two year period, and that all cash flows occur at year ends. The present value V_0 of the regulated entity's revenues net of opex (*OP*) and capex (*CAP*) plus the regulatory asset value in two years' time (B_2) will then be as follows, using the correct (but unknown discount rate k):[7]

$$V_0 = \frac{E(REV_1) - E(OP_1) - CAP_1}{1+k} + \frac{E(REV_2) - E(OP_1) - CAP_2 + B_2}{(1+k)^2}$$

As usual, the price cap should be chosen so that the expected revenues in each year match expected opex, depreciation (D_1 and D_2 for years 1 and 2), and the cost of capital at some allowed rate R per year applied to the regulatory book value at the beginning of each year. It follows that

$$V_0 = \frac{D_1 + B_0 R - CAP_1}{1+k} + \frac{D_2 + B_1 R - CAP_2 + B_2}{(1+k)^2}$$

The regulatory book values B_1 and B_2 follow from the depreciation charges and the capex, and hence

$$\begin{aligned} V_0 &= \frac{D_1 + B_0 R - CAP_1}{1+k} + \frac{D_2 + (B_0 - D_1 + CAP_1)R - CAP_2 + (B_0 - D_1 + CAP_1 - D_2 + CAP_2)}{(1+k)^2} \\ &= \frac{D_1 + B_0 R - CAP_1}{1+k} + \frac{(B_0 - D_1 + CAP_1)(1+R)}{(1+k)^2} \qquad (6) \end{aligned}$$

[7] Capex is treated as non-stochastic, in order to simplify the presentation, but this assumption does not affect the result.

To assess the relative merits of arithmetic and geometric averages, suppose that the cost of capital chosen by the regulator (*R*) is one of these two types of averages. It follows that *R* will be a random variable and therefore the value now of the regulated entity (V_0) will also be a random variable. For some values of *R*, the present value V_0 will be too low, i.e., below the current regulatory book value B_0. For other values of *R*, V_0 will be too high. The regulator should therefore choose the process for estimating *R* so that $E(V_0) = B_0$, i.e., across the possible values for *R*, the expectation of V_0 matches the current regulatory book value B_0. Substituting this into equation (6) yields

$$B_0 = \frac{D_1 + B_0 E(R) - CAP_1}{1+k} + \frac{(B_0 - D_1 + CAP_1)[1 + E(R)]}{(1+k)^2}$$

It follows that $E(R) = k$, i.e., the expected value of the annual regulatory cost of capital must be equal to the true (but unknown) annual cost of capital in order for $E(V_0) = B_0$. The geometric mean fails this test whilst the arithmetic mean will satisfy it if annual returns are independent and drawn from the same distribution. So, if historical average returns are used, they should be arithmetic rather than geometric.

In summary, I concur with the AER's current approach to estimating the cost of capital in which the current risk free rate is coupled with an estimate of the forward-looking MRP. However, whilst the AER uses the current ten-year risk free rate within the first term of the CAPM, I favour the rate whose term matches the regulatory cycle to ensure that the present value of the regulated entity's future cash flows matches its initial investment. In addition, whilst the AER gives primary weight to historical averaging of excess returns and survey results in estimating the forward-looking MRP, I consider that the AER should give consideration or additional weight to a number of other methods including the Siegel approach, the DGM, and results from a range of other markets. In addition, if historical average returns are used, they should be arithmetic rather than geometric averages.

7. Conclusions

This paper has sought to address a number of questions posed by the AER, and the conclusions are as follows.

The first of these questions is the validity of CEG's claim that there is a clear negative relationship between the ten year CGS yield and the ten year MRP to the extent that the ten-year cost of equity is stable over time, and therefore recent reductions in the ten-year CGS yield do not reduce the ten-year cost of equity. I do not consider that CEG present any persuasive evidence that there is a *strong* negative relationship of this kind and the primary evidence they do present in their Figure 8 is pre-disposed to that result by assuming that the future cost of equity is the same for all future years.

The second of these questions involves critically reviewing three approaches to estimating the cost of equity that are proposed by CEG, involving the DGM applied to individual firms, the DGM applied to the MRP, and averaging the risk free rate over a long period. Applying the DGM approach to individual firms is very similar to applying it to the MRP but has the additional problems of greater exposure to fluctuations in the earnings payout rate, incentives for the firms in question to manipulate their earnings payout rate, and implicitly (and wrongly) assumes that the entire firms' activities are regulated. Consequently, I do not favour this approach. Averaging the risk free rate over some historical period is subject to a number of problems, involving overestimating the cost of equity for businesses with equity betas less than 1, wrongly assuming that the widely employed MRP estimate of 6% is an estimate of the long-term average MRP, ambiguity over the 'correct' averaging period for the risk free rate, the unsubstantiated belief that variations in the MRP and the risk free rate are largely offsetting, the sacrifice of an observable, relevant and significant parameter, and potential spillover effects on the estimated cost of debt. I think these problems are sufficiently pronounced that this methodology should not be employed. By contrast, using the DGM to estimate the MRP is worthy of consideration but as a complement to rather than a substitute for the AER's current approach. Furthermore, amongst its many drawbacks is the likelihood that it would currently overestimate the MRP due to assuming that future costs of equity are the same for all future years.

The third question is whether CEG's MRP estimate of 8.52% from the AMP variant on the DGM approach is a reasonable estimate. I identify two significant errors in this approach and the net effect of them is to overestimate the MRP by about 1%. This is in addition to the overestimation referred to in the previous paragraph.

The fourth question involves critically reviewing the AER's belief that its current approach involves using the current ten-year risk free rate and an estimate of the MRP over the next ten years, along with Aurora's view that the AER's MRP is for a much longer and therefore inconsistent period. I concur with the AER's position. The fact that the AER bases its MRP estimate at least partly upon historical averaging of excess returns does not invalidate its claim that it is estimating the MRP for the next ten years; this estimation methodology is suitable (in conjunction with other methodologies) for estimating the MRP for the next ten years as well as for estimating the long-term average MRP. Furthermore, the use of historical averaging results *may* introduce a downward bias at the present time, but the effect is likely to be small relative to the standard deviation in the estimate and to possible upward bias in the methodology arising from significant unanticipated inflation in the 20th century.

The fifth question is whether the AER's use of the current ten year CGS yield, along with an estimate of the MRP for the next ten years that has not changed as the ten-year CGS yield has recently declined, is reasonable in view of the realised returns from other assets of comparable risk, expected returns for the same assets, and opportunity cost considerations. Realised returns are not relevant here and opportunity cost is synonymous with the expected return from assets of comparable risk. The expected returns on these assets are also reduced by the recent decline in the ten-year CGS yield and therefore the only remaining issue is whether the MRP for the next ten years has risen in the last year to counteract the fall in the ten-year CGS yield. This is CEG's argument, but the evidence they present in support of it is not convincing.

The final question is whether the AER's current methodology is appropriate in current market conditions. I concur with the AER's current approach to estimating the cost of capital in coupling an estimate of the forward-looking MRP with the current risk free rate. However, whilst the AER uses the current ten-year risk free rate within the first term of the CAPM, I favour the rate whose term matches the regulatory cycle to ensure that the present value of the regulated entity's future cash flows matches its initial investment. In addition, whilst the AER gives primary weight to historical averaging of excess returns and survey results in estimating the forward-looking MRP, I consider that the AER should give consideration or additional weight to a number of other methods including the Siegel approach, the DGM, and results from a range of other markets. In addition, if historical average returns are used, they should be arithmetic rather than geometric averages.

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1977-78	Auditor with Arthur Young, Wellington, New Zealand
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Todd Energy Ltd, November 2008, expert witness in the *Todd-Shell Arbitration*, concerning the appropriate tariffs on a set of gas industry assets.

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New Zealand Defence Forces, November 2009, advice on charging airlines for Ohakea landing rights.

Queensland Competition Authority, December 2009, advice on the appropriate term of the risk free rate in the context of price control.

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Commerce Commission, September 2010, preparation of, *Comments on Measurement Error and Regulated Firms' Allowed Rates of Return*.

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General Distributors Limited, December 2010, expert witness in the *General Distributors-Casata Arbitration*, concerning the appropriate rental rate on a ground lease.

Queensland Competition Authority, January 2011, preparation of *The Estimated WACC for the SEQ Interim Price Monitoring* (www.qca.org.au).

Australian Energy Regulator, February 2011, expert witness in the case of *ActewAGL Distribution v AER*, relating to the appropriate averaging term for the risk free rate.

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Normanby Properties Ltd, October 2011, expert witness in the *Dilworth Trust Board – Normanby Properties Ltd Arbitration*, concerning the appropriate rental rate on a ground lease.

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OTHER PROFESSIONAL ACTIVITIES

In 1989 I was a member of the Treasury Working Party formulating the Capital Charge Regime for Government Departments.

In 1996 I was a member of the New Zealand Society of Accountants Working Party concerned with responding to the proposed International Accounting Standard on Earnings Per Share.

I was a member of the Index Committee of the New Zealand Stock Exchange (1996-1998).

I was a co-Editor of *Pacific Accounting* Review (2003-2006).

I was on the Editorial Board of *The New Zealand Investment Analyst* (1998-2006).

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