REVIEW OF PARAMETERS IN THE NATIONAL ELECTRICITY RULES

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EXECUTIVE SUMMARY

The Australian National Electricity Rules have prescribed certain parameter values to be used in determining the revenue caps for electricity transmission businesses. These include an equity beta of 1 and a "gamma" value of 0.50. This paper has reviewed these two parameter values and the principal conclusions are as follows.

In respect of the equity beta, the prescribed value of 1 in conjunction with a prescribed leverage ratio of 0.60 implies an asset beta of about 0.44; this is significantly in excess of the estimate of .30 that is considered to be appropriate based upon a review of the asset betas of electric utilities subject to the US regulatory regime. Furthermore, and consequent upon the AEMC's acknowledgement that the prescribed value of 1 constitutes an overestimate in the interests of erring on the side of caution, the degree of overestimation is not transparent and therefore denies interested parties any real opportunity to contest it. Furthermore, and again consequent upon the AEMC's acknowledgement that the prescribed value of 1 constitutes an overestimate in the interests of erring on the side of caution, the upward adjustment of individual parameters rather than the WACC value induces excessive upward adjustment.

In respect of gamma, the prescribed value of 0.50 represents the product of the imputation attachment rate and the utilisation rate by investors, with values of about 0.80 and 0.60 respectively. In respect of the attachment rate, for which the AEMC defers to the ESC in supporting a value of 0.80, the ESC offers two arguments in support of this figure. The first argument involves reference to the dividend franking rate, which is irrelevant, whilst the second argument invokes data that implies a value of 1 rather than 0.80. It follows that the ESC and therefore the AEMC ought to favour an attachment ratio of 1.

In respect of the utilisation rate, the AEMC again relies upon the ESC, who in turn accords most weight to the dividend drop-off work of Capital Research. However, the analysis by Capital Research contains an error and correction of this error would raise the ESC's preferred figure of 0.60 to 0.75. In conjunction with an attachment rate of 1, gamma should then be 0.75 rather than 0.50. Furthermore, estimation of the utilisation rate through this methodology generates an estimate that reflects the presence of foreign investors, and this is inconsistent with the use of the Officer version of the CAPM because this model assumes that national equity markets are segmented. In the face of this inconsistency, a minimum requirement is that the results from using the Officer model in conjunction with an estimate of the utilisation rate based upon dividend drop-off studies should lie within the bounds arising from complete segmentation of national equity markets and complete integration. However, the approach described here fails this test, and is therefore wrong. Consequently, the Officer model should be combined with a utilisation rate on imputation credits that does not take account of foreign investors; this implies a utilisation rate of 1 rather than the value of 0.60 or even 0.75. In conjunction with an attachment rate of 1, gamma should then be 1 rather than 0.50 or 0.75.

If a gamma value of 1 and an asset beta of .30 are adopted, the implied equity beta is 0.75. Using an equity beta of 0.75 and gamma of 1, in substitution for the values of 1 and 0.50 respectively that are prescribed by the National Electricity Rules, the effect is to lower the allowed revenues for regulated firms. Consideration of a recent case gives rise to a reduction of 8%.

1. Introduction

The Australian National Electricity Rules (2007) have prescribed certain parameter values to be used in determining the revenue caps for electricity transmission businesses. These include an equity beta of $\beta_e = 1$ (ibid, p 468) and a "gamma" value of $\gamma = 0.50$ (ibid, p 471). This paper seeks to review these two parameter values.

2. Equity Beta

2.1 Introduction

In evaluating a rule, the natural starting point lies in the justification offered by the guardian of the rules, which is the Australian Energy Market Commission (AEMC). In a recent review, the AEMC (2006, pp. 87-88) supports an equity beta of 1 on the grounds that there is "general acceptance" of it amongst regulators and a value of 1 "represents a compromise between the difficulties of estimation and the consequent need to err on the side of caution." The claim of "general acceptance" amongst regulators appears to be valid although it is arguable whether this is a good basis for reaching a decision. Nevertheless, this paper does not seek to critique such a process. Instead, we examine the claim that an equity beta of 1 is in fact a deliberate overestimate. In particular, we seek to determine whether a value of 1 does constitute an overestimate and, if so, what the likely extent of the overestimation is. In the event of concluding that it is an overestimate, we then consider whether such an approach to addressing estimation error is appropriate.

Before proceeding in this way, a preliminary point should be made. The National Electricity Rules specify values for a number of additional parameters, including a leverage value of 0.60 (AEMC, 2007, p 468). Having prescribed a value for the equity beta, prescribing a value for leverage is essential because a leverage value is both implicit in an equity beta and is used elsewhere in the cost of capital calculation. However, having prescribed both an equity beta and a leverage level, the National Electricity Rules have effectively prescribed an asset beta (the equity beta in the absence of debt). Consequently, if we accept the leverage value of 0.60, any assessment of whether an equity beta of 1 is appropriate is equivalent to an assessment of the underlying asset beta. Furthermore, any assessment of the appropriateness of the beta should involve an assessment of the betas of relevant companies, and their leverage levels in general do not conform to the figure of 0.60 prescribed in the National Electricity Rules. Consequently, it will be necessary to adjust for the difference in leverages, and the simplest process for doing so is to convert all equity betas to their underlying asset betas. This requires a model that relates the equity beta to the asset beta and leverage ("gearing formula"). However, the National Electricity Rules do not specify any such model. Nevertheless, the National Electricity Rules define the company tax rate to be net of the imputation effect, in accordance with the Officer (1994) model, i.e., imputation is treated as a company rather than a personal tax phenomenon. Consistent with this, the appropriate gearing model is that of Hamada (1972) with the statutory company tax rate replaced by the imputation-adjusted company tax rate[1]. This model is then as follows

$$\beta_e = \beta_a \left[1 + \frac{L}{1-L}(1 - T_c(1-\gamma)) \right] \tag{1}$$

where β_a is the asset beta, L is leverage, and T_c is the statutory corporate tax rate. With leverage of 0.60, a statutory corporate tax rate of .30, $\gamma = 0.50$, and $\beta_e = 1$, the implied value for the asset beta is $\beta_a = 0.44$. We now turn to assessing an appropriate value for the asset beta.

2.2 The Asset Beta for Electricity Transmission Businesses

In seeking to estimate the appropriate asset beta for electricity transmission businesses in Australia, the natural source of estimates is (listed) Australian firms of this type. However, only one of these firms is listed.[2] Furthermore, even if all seven of these firms were listed, the number would still be too small and the time period for which they have operated under the present regulatory regime too short to permit a reliable estimate to be generated in this way. Thus, it is necessary to seek out a set of comparators that is both large and has been subject to a similar regulatory regime for an extended period. Comparators should also be involved in electricity transmission or closely related activities.

[1] The Hamada (1972) model is also used to generate the asset beta estimates for the US firms that will be examined shortly. Accordingly, the estimates will be consistent.

[2] This firm is SPAusNet. Of the other transmission firms, Electranet, Directlink and Murraylink are privately owned but unlisted whilst Powerlink, Transgrid and Transend are publicly owned.

The critical features of the Australian regime in question are as follows. Firstly, revenues are capped and this essentially protects firms against output (demand) shocks because costs are largely invariant to output (AEMC, 2006, pp. 40-41). Secondly, revenues are capped for five years (ibid, pp. 54-56), and this potentially exposes the firms to cost shocks within a regulatory cycle. Thirdly, regulated firms are largely protected against cost shocks within a regulatory cycle that are "systematic" in nature, because of the right to apply for a reset of the revenue cap within a regulatory cycle in response to unforeseen events (AEMC, 2007, pp. 480-487); systematic cost shocks are, by their very nature, unforeseen. These features of the regulatory regime collectively suggest that firms would have very low exposure to systematic risks, and therefore a very low asset beta. An alternative regulatory regime is that faced by regulated US electric utilities[3]. In particular, prices are set consistent with the firm's actual costs (subject to the possibility of some costs being disallowed) and a prescribed rate of return. In addition, prices are reset if the actual rate of return deviates materially from the prescribed rate, with resetting initiated by either the firm or its customers. Clearly, these US and Australian regimes are different. However, the effect of both regimes is to largely insulate the firms from systematic risks; the US firms achieve this through price resetting when required whilst the Australian firms achieve this through a mixture of revenue capping, automatic resetting every five years and the right to apply for an earlier reset in response to unforeseen events.

In addition to these similarities in regulatory regime, the set of these US firms is very large and the regulatory regime has been largely unchanged for decades. This permits asset beta estimates to be generated for a large set of firms and over a protracted period, with consequent improvements in the reliability of the estimates. Lally (2005,

[3] These firms are either vertically integrated (the activities comprising generation, transmission, distribution and retail) or confined to transmission and/or distribution. Prior to 1998, they were all vertically integrated and all elements of the chain of activities were regulated in all states. Since 1998, deregulation has occurred in some states and has involved opening up retail and generation activities to new (unregulated) firms. However, even in these states, transmission and distribution activities continue to be regulated. Furthermore, in these states, firms that are still vertically integrated continue to be subject to controls upon their retail and generation charges (Joskow, 2005, pp. 56-57).

pp. 41-44) has recently compiled or generated a large set of estimates for these US firms, as shown in Table 1.[4]

Table 1: Asset Beta Estimates for US Electric Utilities

Source	Data Period	Estimate	Number
Value Line	1999-2003	.26	64
Value Line	1994-1998	.26	93
Bloomberg	2002-2003	.27	68
Alexander	1990-1994	.30	9
Ibbotson	1999-2003	.12	41
Ibbotson	1993-1997	.32	66
S & P	1999-2003	.18	42
S & P	1994-1998	.19	37
S & P	1989-1993	.31	36
Median		.26	42

The results range from .12 to .32, with a median of .26. The outliers in the set of results are the most recent Ibbotson estimates. A possible explanation is offered by Annema and Goedhart (2003), who show that industry equity betas for the TMT sector (telecommunications, media and technology) were unusually high in the period 1998-2001, while those for other industries were unusually low. The reason here may be chance or a reflection of the (temporary) surge in the market weight of the TMT sector in the period 1998-2001[5]. If this is the explanation, then it has not affected the S & P results to this degree, and does not *seem* to have affected the Value Line results at all. The effect of simply ignoring all estimates that draw upon data from the period

[4] Unlike the estimates in Lally (2005), no correction has been made for differences in market leverage between the US and the "local" market (Australia in this case). The effect of this was small in Lally (2005) and is likely to be small in this case.

[5] If the market is partitioned into the TMT and other sectors, and the former beta is higher than the latter, then a rise in the market weight of the TMT sector must induce a reduction in the betas of the other sectors, because the weighted average beta is necessarily equal to one. If, in addition, the beta of the TMT sector also rises, then the reduction in the beta of the other sectors will be even greater.

1998-2001 inclusive is to raise the median of the overall results only slightly, from .26 to .28. Taking account of all this, and the merits of rounding estimates of the asset beta obtained in this way, I favour an estimate of .30 for the asset beta of the US firms.

Having concluded that an appropriate estimate for the asset beta of regulated US electric utilities is 0.30, and that the Australian firms face similar systematic risk (as discussed above), an appropriate estimate for the Australian firms would also be 0.30. This contrasts dramatically with the estimate of 0.44 implied by the prescribed equity beta of 1, as derived in the preceding section. Expressed another way, an estimate for the asset beta of 0.30 in conjunction with the gearing formula (1) and leverage of 0.60, a corporate tax rate of 30% and gamma of .50, gives rise to an estimate for the equity beta of 0.68 rather than the estimate of 1 favoured in the National Electricity Rules.

2.3 Possible Estimation Errors

We turn now to the argument that overestimation of beta is justified by the need to "err on the side of caution." It is uncontroversial that the consequences of underestimating WACC are more severe than overestimation, because the former deters investment by firms whilst the latter leads only to excessive prices being imposed upon customers, and that this asymmetry justifies an allowed rate of return in excess of an unbiased estimate of WACC.[6] However, any such adjustment should satisfy two requirements. Firstly, it should be transparent, so as to provide interested parties with a real opportunity to contest the adjustment. The right to contest a regulatory judgement is vacuous unless the regulator's judgements are transparent.

Secondly, any adjustment should be made directly to WACC rather than to the beta (and presumably also to the market risk premium) or else the upward adjustment for the possibility of estimation error will be too large. To illustrate this point, suppose that the firm is entirely debt financed and therefore the WACC is estimated using the Officer (1994) version of the CAPM, i.e.,

[6] By contrast, the *extent* to which one should raise the allowed rate of return is controversial. This paper does not present a view on this question.

$$k = R_f + \phi\beta \tag{2}$$

In this model, the risk free rate is certain but uncertainty exists over the market risk premium ϕ and the asset beta β. Letting unbiased estimates of these two parameters be denoted by $\hat{\phi}$ and $\hat{\beta}$, the variance in the estimated WACC ($\hat{k}$) is as follows:

$$Var(\hat{k}) = Var(\hat{\phi}\hat{\beta})$$

Errors in estimating the market risk premium and beta would seem to be uncorrelated or nearly so.[7] In this case

$$\begin{aligned} Var(\hat{\phi}\hat{\beta}) &= E\left[\hat{\phi}\hat{\beta} - E(\hat{\phi})E(\hat{\beta})\right]^2 \\ &= E(\hat{\phi}^2)E(\hat{\beta}^2) - E^2(\hat{\phi})E^2(\hat{\beta}) \\ &= \left[Var(\hat{\phi}) + E^2(\hat{\phi})\right]\left[Var(\hat{\beta}) + E^2(\hat{\beta})\right] - E^2(\hat{\phi})E^2(\hat{\beta}) \\ &= Var(\hat{\phi})Var(\hat{\beta}) + E^2(\hat{\phi})Var(\hat{\beta}) + E^2(\hat{\beta})Var(\hat{\phi}) \end{aligned} \tag{3}$$

Consider the following example. Suppose R_f = .055, $\hat{\phi}$ is normally distributed with a standard deviation of .015, $\hat{\beta}$ is normally distributed with a standard deviation of .15, and the unbiased estimates for ϕ and β are .05 and .30 respectively. In addition, a regulator chooses values for ϕ and β, denoted ϕ_R and β_R respectively, that reduce the chance of underestimation to 25%. In respect of the market risk premium, this means that the probability of ϕ_R being less than ϕ is .25, i.e.,

$$\Pr ob(\phi_R \leq \phi) = .25$$

The value ϕ_R chosen by the regulator constitutes the unbiased point estimate $\hat{\phi}$ plus a margin *m*. So

[7] This occurs because estimates of the market risk premium draw upon data other than historical data (such as forward-looking estimates), because even the historical data used here spans a much longer period than that used in beta estimates (100 years versus 20 years at most), because the historical data used in estimating the market risk premium spans many markets, and because historical data used in estimating market risk premiums is concerned with average values rather than sensitivity coefficients.

$$\Pr ob(\hat{\phi} + m \leq \phi) = .25$$

Since $\hat{\phi}$ is assumed to be normally distributed around the true but unknown value ϕ with standard deviation .015, it follows that

$$\hat{\phi} = \phi + .015Z$$

where Z is the standard normal random variable. Substitution of this into the penultimate equation yields

$$\Pr ob\left(Z \geq \frac{m}{.015}\right) = .25$$

and therefore

$$\frac{m}{.015} = .675$$

and therefore

$$m = .675(.015) = .010$$

The value ϕ_R chosen by the regulator is then as follows:

$$\phi_R = \hat{\phi} + m = .050 + .675(.015) = .060$$

Similarly

$$\beta_R = .80 + 0.675(.15) = .40$$

Substitution of these last two results into equation (2) yields the regulator's value for WACC as follows:

$$k_R = .055 + (.06)(.40) = .079$$

By contrast, had the regulator invoked the unbiased estimates for ϕ and β of .050 and .30 respectively, substitution into equation (2) would have yielded k_R = .070. So, the regulator has effectively invoked a margin of .009 in the WACC. Turning to equation (3), and invoking the estimates assumed above for the individual parameters, it follows that

$$Var(\hat{k}) = .015^2(.15^2) + .05^2(.15^2) + .30^2(.015^2) = .0000814$$

This implies a standard deviation for the WACC estimate of .009. Using this result, the margin of .009, and assuming that the distribution of $\hat{k}$ is normal, the probability of the regulator's value k_R being less than the true value k is as follows:[8]

$$\begin{aligned}
\Pr ob(k_R \leq k) &= \Pr ob(\hat{k} + .009 \leq k) \\
&= \Pr ob(k + .009Z + .009 \leq k) \\
&= \Pr ob(Z \leq -1) \\
&= .16
\end{aligned}$$

Thus, if a regulator chooses values for ϕ and β that each involve only a 25% chance of being too low, the resulting value for WACC will have only a 16% chance of being too low, i.e., the degree of protection against estimation error will have been significantly increased. Such an increase would not be intentional. Consequently, if protection is sought against estimation error through addition of margins to estimates of individual parameters rather than to the WACC value, the result will be an excessive degree of protection.

In summary, the AEMC's practice of raising its estimates for parameters to reflect estimation error should satisfy two requirements: transparency and adjustment at the WACC level rather than at the individual parameter level. The AEMC's practice fails both requirements, and the second failure will induce an excessive adjustment for estimation error.

3. Gamma

3.1 Introduction

As with the equity beta, the natural starting point in assessing the merits of a gamma value of 0.50 lies in the justification offered by the AEMC. In a recent review, the

[8] The distribution of $\hat{k}$ will not be normal, due to the multiplication rather than the addition of $\hat{\phi}$ and $\hat{\beta}$. However, normality will be a good approximation.

AEMC (2006, pp. 87-88) supported a gamma value of 0.50 primarily on the grounds that the Essential Services Commission (ESC) has recently examined the question and "determined that there was inadequate evidence to support changing the value of gamma from 0.50" (ESC, 2005, pp. 400-413). In turn, the ESC "…placed substantial weight on its previous decisions and those of other regulators…" (ibid, p 402). These other regulators have in turn adopted the same approach, with each new decision providing further support for the status quo without adding to the real evidence on the question. However, the ESC does also conduct a review of the real evidence on this question. It commences by noting (correctly) that gamma is the product of the utilisation rate on credits that have been attached to dividends (θ) and the proportion of company tax that is attached to dividends in the form of imputation credits (ω), i.e.,

$$\gamma = \theta\omega \tag{4}$$

The ESC goes on to state that its estimate for θ is about .60 and its estimate for ω is about .80 (ibid, p 411). We consider each of these two parameter estimates in turn.

3.2 The Attachment Rate

The ESC's estimate for the attachment rate ω of 0.80 is drawn from recent work by Capital Research (ESC, 2005, p 411). Although Capital Research (2004, pp. 9-12) concludes that the attachment ratio is 0.71, the ESC raises two contrary arguments in support of the higher figure of 0.80. Firstly, it notes that "..the most recent values are close to 80%..." (ESC, 2005, p 411). The source of this claim is clearly Figure 3 in Capital Research (2004), in particular to "..franked dividends as a proportion of total dividends per annum". However, the ratio of franked to total dividends is not equivalent to the attachment rate ω. For example, suppose a company pays company taxes of \$2m, issues cash dividends of \$5m, and assigns all company taxes as imputation credits.[9] In this case, the attachment ratio is 1 but only \$4.67m of the dividends will experience full franking, and therefore the ratio of franked to total dividends will be 0.93. Alternatively, suppose that the company paid company taxes of \$2m and cash dividends of \$3m. In this case, only \$1.29m of the company tax could be attached as imputation credits. Accordingly, the attachment rate would be

[9] At a company tax rate of 30%, the cash dividends of \$5m would allow a maximum attachment of imputation credits of \$2.14m, and therefore the attachment of \$2m would be legitimate.

$1.29/$2m = 0.64 whilst the ratio of franked to total dividends would be 1. Thus, the ratio of franked to total dividends is a completely different concept to that of the attachment rate. Accordingly, the ESC's reference to the figure of 0.80 in Figure 3 of Capital Research (2004), as if it were a reference to the attachment rate ω, is wrong.

Secondly, the ESC notes that Capital Research's figure of 0.71 is an average over all firms (this is correct), and that electricity distributors are likely to experience larger values. In particular, the ESC claims that "..the distributors could distribute all of the franking credits forecast to be created over the next regulatory period with only modest distributions…" (ESC, 2005, p 412). However, if the ESC's claim is really true, the implied value for the attachment rate ω is not 0.80 but 1. Furthermore, in a subsequent report, the ESC (2007, p 430) accepts that the appropriate value for this parameter is in fact 1.

In summary, the ESC presents two arguments in support of a value of 0.80 for the attachment ratio. The first argument involves reference to the dividend franking rate, which is irrelevant. The second argument invokes data that implies a value of 1 rather than 0.80. It follows that the ESC ought to favour an attachment ratio of 1. Since the AEMC draws upon their analysis, the AEMC ought to adopt the same value.

3.3 The Utilisation Rate

The ESC's (2005) estimate for the utilisation rate θ of 0.60 is drawn primarily from a review of the results from dividend drop-off studies, with a particular emphasis upon recent work by Capital Research (ESC, 2005, p 411).[10] Capital Research (2004, pp. 17-24) concludes that the utilisation rate is about 0.50. However, the ESC notes that the ratio has exceeded 0.60 in recent years and therefore continues to favour that value. Recourse to the work of Capital Research presumes that their analysis is accurate. However, they have underestimated the utilisation rate through a conceptual error as follows.

[10] There is some ambiguity in the ESC's work on this question. Despite recognising that gamma is the product of the attachment rate and the utilisation rate, and that the utilisation rate can be estimated through the dividend drop-off approach, they also claim that the dividend drop-off approach estimates "the value of franking credits" (ESC, 2005, p 410) and they equate the latter with gamma (ibid, p 400). However, I have interpreted their assessment of the results from dividend drop-off studies to be an assessment of the utilisation rate, which is only one component of gamma.

Capital Research conducts three regressions, corresponding to their equations (3), (4) and (5). They appear to focus upon the results from equation (3), which is developed as follows. Letting ΔP denote the share price change over the period surrounding the ex-dividend date, *DIV* denote the cash dividend, and *FC* denote the franking credits

$$\Delta P = aDIV + bFC + e \tag{5}$$

where *e* is the regression residual, *a* is the value per $1 of cash dividend, and *b* is the value per $1 of franking credit. The franking credit is the product of the cash dividend *DIV*, the proportion of the dividend that is fully franked (*f*), and the maximum franking rate, as follows

$$FC = DIVf\left[\frac{t}{1-t}\right] \tag{6}$$

where *t* is the statutory company tax rate. Substitution of this equation into the preceding equation, followed by dividing through by *DIV*, yields the following regression model[11]

$$\frac{\Delta P}{DIV} = a + bf\left[\frac{t}{1-t}\right] + u \tag{7}$$

where *u* is the new regression residual. Capital Research equates the coefficient *b* with the utilisation rate, and thereby generate an estimate of 0.52 (ibid, p 21). This is only true if cash dividends are fully valued, i.e., *a* = 1. However, Capital Research find that *a* is less than 1, presumably because cash dividends are taxed more heavily than capital gains. The coefficient *b* must be subject to the same issue, and therefore cannot be equal to the utilisation rate. In recognition of this point, equation (5) above should have been expressed as follows.

$$\Delta P = a\left[DIV + \theta FC\right] + e$$

[11] Capital Research actually run the regression without the term [ ], and subsequently correct for this omission. Their rationale for doing so is not apparent. However, their two-step process is equivalent to that shown here.

Substituting equation (6) into this, and dividing through by *DIV*, yields the following

$$\frac{\Delta P}{DIV} = a + a\theta f\left[\frac{t}{1-t}\right] + u \tag{8}$$

This can be written in the form shown in equation (7) above; comparison of equations (7) and (8) then shows that $b = a\theta$. Thus, using Capital Research's estimates for *a* and *b* of 0.80 and 0.52 respectively (ibid, Table 3), the implied estimate for the utilisation rate θ is

$$\theta = \frac{a}{b} = \frac{.52}{.80} = .65$$

rather than 0.52. As noted above, the ESC rejects the figure of 0.52 in favour of a value of 0.60 on the grounds that the latter figure is supported by Capital Research's more recent results. However, those more recent results are subject to the same understatement afflicting the figure of 0.52, i.e., they are still an estimate of *a* rather than the utilisation rate θ. So, making the same adjustment shown above, a figure of 0.60 becomes a figure of 0.75.

Capital Research (2004) is not the only study referred to by the ESC that seeks to estimate the utilisation rate θ using the "dividend drop-off approach". The ESC refer to three other studies of this type (ESC, 2005, Table 9.24): Hathaway and Officer (1999), Brown and Clarke (1993), and Bruckner et al (1994). However, the Hathaway and Officer study is simply an earlier study by the same authors. Furthermore, all three of these papers cover a significantly shorter period and use less recent data than that of Capital Research (2004). So, given the ESC's preference for studies using the "dividend drop-off approach", the focus upon results from Capital Research (2004) is entirely appropriate.[12]

[12] In a subsequent report, the ESC (2007, p 427) expresses a preference for the estimate of 0.572 derived from Beggs and Skeels (2004, Table 6) and based on data for the period 2001-2004. However, this requires the same type of correction to generate an estimate of the utilisation rate, and doing so yields the estimate of 0.572/0.80 = 0.72.

In summary, the primary source cited by the AEMC for its view that the appropriate value for θ is 0.60 suffers from an error in its analysis, and correction of that error implies that the estimate should be raised from 0.60 to 0.75.

3.4 The Utilisation Rate: An Alternative Approach

A further consideration relating to the ESC's estimate of the utilisation rate is as follows. The fact that dividend drop-off studies point to an estimate for the utilisation rate θ that is less than 1 presumably reflects the presence of foreign investors in the Australian equity market, who cannot use or fully use the credits; this exerts a downward effect on the estimate with a consequent increase in the revenue cap. However, the Officer CAPM that is invoked in the National Electricity Rules assumes that national equity markets are completely segmented, i.e., investors are precluded from purchasing foreign equities.[13] Consequently the use of an estimate for θ that is potentially significantly influenced by the presence of foreign investors is inconsistent with this model. One possible response to this might be to argue that the shortcoming from use of a model that fails to reflect the reality of foreign investors should not be compounded by using an estimate of θ that also fails to reflect the same phenomenon. However, if any methodology partly recognises some phenomenon (such as the presence of foreign investors), it should generate a result that lies between the results that would arise if foreign investors were completely ignored and if they were fully recognised, i.e., it should generate a result that lies between those arising under complete segmentation and complete integration of national equity markets. Otherwise, the recognition of foreign investors solely in respect of imputation credits will constitute cherry-picking to maximise the revenue cap.

To explore this issue, we need to consider the implications for the cost of equity of complete integration of equity markets and complete segmentation. It will also be desirable to impound all of the effects of imputation within the cost of equity capital rather than within the cash flows; it will then be sufficient to examine only the cost of equity capital. We start with complete segmentation, and therefore require a version of the CAPM that is consistent with this. In accordance with the National Electricity Rules, we adopt the Officer (1994) model. This model specifies the cost of equity

[13] The same segmentation assumption underlies the standard CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966).

consistent with cash flows being defined to incorporate the firm-specific effects of imputation. This is denoted $\hat{k}_e$, and is as follows:

$$\hat{k}_e = R_f + \phi\beta_e \tag{9}$$

If the effects of imputation are instead incorporated into the cost of equity, the result (denoted k_e) is as follows

$$k_e = R_f + \phi\beta_e - D_e I_e \theta \tag{10}$$

where D_e is the cash dividend yield for the firm in question and I_e is the ratio of imputation credits to cash dividends for the firm in question (see Lally, 2000, pp. 10-11). Under complete segmentation of equity markets, all investors in Australian stocks would be Australians and virtually all of them can use the imputation credits; so, θ would be close to 1.[14] Letting ϕ_S denote the market risk premium within the Officer model for Australia under complete segmentation, the cost of equity under complete segmentation and inclusive of the effects of imputation credits, denoted k_e^S, would then be as follows

$$k_e^S = R_f + \phi_S \beta_e - D_e I_e \tag{11}$$

Turning now to complete integration of markets, versions of the CAPM have been developed that recognize that international investment opportunities are open to investors, starting with Solnik (1974). We will invoke this model because, dividend imputation aside, it closely parallels the Officer model. As with most international versions of the CAPM, international capital flows are assumed to be unrestricted and investors exhibit no irrational home country biases, i.e., there is no preference for local assets for non-financial reasons. Like the standard version of the CAPM, it assumes that interest, dividends and capital gains are equally taxed. The resulting cost

[14] Consistent with this, Handley and Maheswaren (2007, Table 4) found that 100% of the imputation credits attached to dividends received by Australian resident investors were redeemed against their tax liabilities; their data covered the period since the tax changes in July 2000, which granted rebates to Australian investors who could not fully utilise the credits. In an earlier paper (Handley and Maheswaren, 2003), involving data from the period 1989-2000, their figure was 90%.

of equity for an Australian company under complete integration, denoted k_e^I, would be as follows

$$k_e^I = R_f + \phi_w \beta_{ew} \tag{12}$$

where R_f is (as before) the Australian riskfree rate, ϕ_w is the risk premium on the world market portfolio, and β_{ew} is the beta of the company's equity against the world market portfolio. By contrast with the Officer CAPM, there is no recognition of dividend imputation. However, since most investors in Australia's equity market would be foreigners in this full internationalization scenario, and foreigners gain only slight benefits (at most) from imputation credits under the Australian imputation regime, this feature of the Solnik model is not significant. The remaining, and significant, distinction between the two models lies in the definition of the market portfolio, i.e., the "market" is Australia in the Officer model and the world in the Solnik model. Thus the market risk premiums may differ across the two models and the beta of a firm's equity is defined against a different market portfolio.

The methodology prescribed in the National Electricity Rules, like that of Australian regulatory practice in general, does not conform to either of these extreme models. Instead, the Officer model is invoked with a utilisation rate of about 0.60 and estimates of the market risk premium do not necessarily reflect complete segmentation. With incorporation of the effects of imputation into the cost of equity rather than the cash flows, this is equivalent to invoking equation (10) with θ = 0.60, i.e.,

$$k_e = R_f + \phi\beta_e - D_e I_e(.60) \tag{13}$$

We now seek to compare the regulatory approach in equation (13) to the extreme cases shown in equations (11) and (12).[15] The Australian risk free rate R_f is common to all three models, and therefore the choice of a value is not significant. So, we set the value at .059, corresponding to the yield to maturity on ten year government bonds

[15] The methodology prescribed in the National Electricity Rules differs from that in equation (13) in that the effects of imputation are reflected in the cash flows. However, equation (13) is equivalent to this approach and can therefore be treated as if it were the methodology prescribed in the National Electricity Rules.

on 28 August 2007.[16] In respect of the market risk premium and the equity beta within equation (13), we invoke the values specified in the National Electricity Rules, i.e., ϕ = .06 and β_e = 1.[17] In respect of the ratio of imputation credits to cash dividends, the average over Australian firms is about 0.36 (see Lally, 2006, p 318). However, the value might differ for the regulated firms in question. So, we will consider a range of values around this, from 0.29 up to the maximum value permissible under Australian taxation law of 0.43. In respect of the cash dividend yield, the average over Australian firms is about .04 (ibid, p 318). However, the ESC (2005, pp. 411-412) claims that the dividend yields of regulated firms tend to be larger than Australian firms in general, and the figures presented in a subsequent report range from .056 to .091 (ESC, 2007, Table 10.15). Consequently, a range of cash dividend yields from .05 to .09 will be considered.

In respect of the market risk premium in the Solnik model, in which markets are assumed to be completely integrated, investors will now be holding a world rather than a national portfolio of equities, and the latter will have a considerably lower variance due to the diversification effect. Since the market risk premium is a reward for bearing risk, then the world market risk premium under complete integration should be less than that for Australia under complete segmentation. This market risk premium cannot be estimated in the Ibbotson (2007) fashion, by averaging of the ex-post outcomes over a long period. This is because integration would reduce the market risk premium, and therefore the averaging process would have to be conducted over the period since complete integration. Since complete integration has clearly not been attained, let alone for a long period, there is no relevant data. An alternative approach is suggested by Stulz (1995), who argues that, if the ratio of the market risk premium to variance is the same across countries under segmentation, the same ratio will hold at the world level under integration and this fact should be invoked in estimating the world market risk premium. Letting this ratio be denoted Q, the variance on the world market portfolio be denoted σ_w^2, and the variance on the Australian market portfolio be denoted σ^2, the market risk premium for the Solnik

[16] Data from the website of the Reserve Bank of Australia (www.rba.gov.au).

[17] The same equity beta appears in equation (11), because integration of markets does not affect this parameter. By contrast, integration will tend to affect the value for the market risk premium.

CAPM under complete integration relative to that of the Officer model under complete segmentation would then be as follows:

$$\frac{\phi_w}{\phi_S} = \frac{Q\sigma_w^2}{Q\sigma^2} = \frac{\sigma_w^2}{\sigma^2} \tag{14}$$

So, the ratio of the two market risk premiums is equal to the ratio of the two variances. Using monthly returns data for the Australian and world markets from 1984-2007, the annualised estimates for σ_w^2 and σ^2 are $.143^2$ and $.163^2$ respectively.[18] Using these estimates in conjunction with equation (14), the implied value for ϕ_w is then as follows:

$$\phi_w = \frac{0.143^2}{0.163^2}\phi_S = 0.77\phi_S \tag{15}$$

The parameter ϕ_S reflects complete segmentation of equity markets. By contrast, the parameter ϕ appearing in equation (13) reflects present conditions, which involves some degree of market integration rather than complete segmentation. However, the degree of integration is still rather limited.[19] Furthermore, the AER's estimate of .06 for the parameter ϕ clearly places considerable weight on historical averaging of the Ibbotson (2007) type, and most of this data reflects complete segmentation.[20] In recognition of partial integration, suppose that ϕ lies midway between ϕ_S and ϕ_w. Furthermore, in recognition of the AER's estimate for ϕ placing substantial weight upon historical averaging, suppose that the AER's estimate of .06 lies midway between ϕ_S and the true value for ϕ. It follows that the AER's estimate of .06 lies 25% of the way from ϕ_S to ϕ_w. In conjunction with equation (15), this implies that

[18] The Australian returns are based on the AS30 Index whilst the world returns are based on the MSCI world index.

[19] Coen (2001, Table 1) summarises the results for nine major markets, and reveals that the ratio of domestic to total worldwide equities held by investors exceeds the domestic market weight by a substantial margin in all nine markets (the averages are 82% and 11% respectively).

[20] The AER (2006) refers to the Statement of Regulatory Principles (AER, 2004, section 8.4) in support of the value of .06. The discussion in this section suggests that significant weight is placed upon both historical averaging of the Ibbotson (2007) kind and on forward-looking methods, with the latter reflecting the current situation.

$$\frac{\phi_S - .06}{\phi_S - \phi_w} = \frac{\phi_S - .06}{\phi_S - 0.77\phi_S} = 0.25$$

It follows that $\phi_S = .064$ and $\phi_w = .049$. Since the estimate for the variance ratio shown in the last equation (0.77) may be wrong, a range of values from 0.67 to 0.87 will be considered, implying a range of values for ϕ_w from .044 to .054 (and associated values of ϕ_S from .065 to .062).

The final parameter to estimate is the beta in Solnik's model. The average Australian stock has a beta against the Australian market portfolio of 1, by construction. Similarly, the average asset world-wide has a beta against the world market portfolio of 1, but this does not imply that the average Australian stock has a beta of 1 against the world market portfolio. Ragunathan et al (2001, Table 1) provides beta estimates for a variety of Australian portfolios for the period 1984-1992, against both Australian and world market indexes. The average of the latter to the former is about 0.40. Using more recent data for the Australian and world markets, from 1984-2007, the beta for the Australian market against the world market is 0.65.[21] These results suggest that the betas of Australian firms against the world market portfolio are considerably less than against the Australian market portfolio. Given a prescribed value for β_e of 1, and the estimate of 0.65 described above, we therefore adopt an estimate for β_{ew} of 0.65. However, we will consider a range of values from .50 to .80.

Using these estimates, we now consider the results from equations (11), (12) and (13). For example, suppose that D_e = .05, I_e = .29, ϕ_w = .044, ϕ_S = .065, and β_{ew} = .50. The results from (11), (12) and (13) are then as follows.

$$k_e^S = .059 + .065(1) - .05(.29) = .109$$

$$k_e^I = .059 + .044(.50) = .081$$

$$k_e = .059 + .06(1) - .05(.29).60 = .110$$

[21] The Australian returns are based on the AS30 Index whilst the world returns are based on the MSCI world index. The standard deviation on the estimate of 0.65 is 0.056, and therefore the estimate of 0.65 is both quite precise and statistically significantly different from 1.

The results from the first two of these equations reveal that the effect of shifting from a world of complete segmentation to one of complete integration is to lower the cost of equity from .109 to .081, because the effect of losing the value of imputation credits is outweighed by the reductions in both the market risk premium and the beta. However, the result of .110 from the last of these three equations, whose methodology corresponds to that in the National Electricity Rules, lies outside the bounds provided in the first two equations because recognition of the impact of foreign investors is limited to a reduction in the utilisation rate. The methodology underlying this equation is therefore wrong.

Table 2 below shows the results from equations (11), (12) and (13) in that order, for a range of values for D_e, I_e, ϕ_w, ϕ_S and β_{ew}.[22] The table shows that, with only one exception, the cost of equity that is generated by the Officer model with a utilisation rate on imputation credits of 0.60 rather than 1 is above the higher of the values arising from either complete segmentation or complete integration of equity markets, and is therefore too high. The only exception occurs when the upper limits on ϕ_w, β_{ew}, D_e and I_e are invoked, i.e., $\phi_w = .054$, $\beta_{ew} = .80$, $D_e = .09$ and $I_e = .43$.

In response to this general line of argument, the ESC (2007, p 424) argues that estimates of the market risk premium (in the Officer model) reflect current conditions and therefore take account of the existing degree of market integration. However, as discussed above, estimates of the market risk premium in the Officer model only partly reflect current conditions because considerable weight is clearly placed upon estimates based upon historical averaging. Furthermore, even taking account of this point, the results in Table 2 show that conventional practice amongst Australian regulators generates costs of equity that fail a basic test: they lie outside the bounds arising from either complete segmentation or complete integration of equity markets.

[22] The results for the preceding example are shown in the first three rows of the first column of the main body of the Table.

Table 2: The Cost of Equity Capital Under Three Models

			I_e = .29		I_e = .36		I_e = .43	
ϕ_w	ϕ_S	β_{ew}	D_e = .05	D_e = .09	D_e = .05	D_e = .09	D_e = .05	D_e = .09
			.109	.098	.106	.092	.102	.085
.044	.065	.50	.081	.081	.081	.081	.081	.081
			.110	.103	.108	.100	.106	.096
			.109	.098	.106	.092	.102	.085
.044	.065	.80	.094	.094	.094	.094	.094	.094
			.110	.103	.108	.100	.106	.096
			.106	.095	.103	.089	.099	.082
.054	.062	.50	.086	.086	.086	.086	.086	.086
			.110	.103	.108	.100	.106	.096
			.106	.095	.103	.089	.099	.082
.054	.062	.80	.102	.102	.102	.102	.102	.102
			.110	.103	.108	.100	.106	.096

In summary, the National Electricity Rules prescribe the Officer model in conjunction with an estimate of the utilisation rate on imputation credits of 0.60. These practices are inconsistent because the Officer model assumes that national equity markets are segmented whilst an estimate of the utilisation rate on imputation credits of 0.60 reflects the presence of foreign investors. In the face of this inconsistency, a minimum requirement is that the results from this approach should lie within the bounds arising from complete segmentation of national equity markets and complete integration. However, the approach prescribed in the National Electricity Rules fails this test in virtually every case examined, and is therefore wrong. Consequently, the Officer model should be combined with a utilisation rate on imputation credits of 1 rather than the value of 0.60; if this is done, the test describe here would be satisfied in most cases.

4. Implications for Allowed Revenues

Having argued that the asset beta has been overestimated (0.44 rather than 0.30) and that gamma has been underestimated (0.50 rather than 1), this section explores the implications of these two new estimates for allowed revenues. The implications for allowed revenues will vary across regulatory situations. So, we consider a recent example involving the Australian Energy Regulator (AER, 2007). The revenues allowed total \$3334.01m over the five year regulatory cycle (ibid, Table 8.3).[23] Inter alia, this involves an estimate for the weighted average cost of capital (*WACC*) as follows

$$\hat{k}_e = R_f + \phi\beta_e \tag{16}$$

$$WACC = \hat{k}_e(1-L) + k_d L \tag{17}$$

where the first of these equations is the Officer (1994) CAPM invoked by the AER, and the second is the vanilla *WACC* model invoked by the AER. The AER's (2007, Table 5.4) estimates of these parameters are β_e = 1, ϕ = .06, L = 0.60 (all in accordance with the National Electricity Rules), R_f = .0568, and k_d = .0682. These parameter values imply that *WACC* = .0876. To re-estimate the WACC, we additionally require a beta gearing formula. As shown in equation (1), this is as follows:

$$\beta_e = \beta_a\left[1 + \frac{L}{1-L}(1 - T_c(1-\gamma))\right]$$

Using our recommended estimates for β_a = .30 and γ = 1, in conjunction with L = 0.60 (as above) and the Australian corporate tax rate of T_c = 0.30, the resulting estimate for the equity beta is β_e = 0.75. Substitution of this estimate into equation (16) and then (17), along with the other parameter values invoked by the AER, leads to an estimate for *WACC* of .08164 rather than .0876. Accordingly, the "Return on Capital" within the revenue calculation of the AER (2007, Table 8.3) must be modified. In addition, if gamma is raised to 1, then the "Net taxes payable" within the revenue calculation of the AER (ibid) falls to zero. The revenue calculation in that Table is then revised and shown in Table 3.[24]

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[23] These are the "unsmoothed" revenues, which are subject to a smoothing correction. However, the effect of this upon the total revenues for the five years cycle is minor and therefore we focus upon the unsmoothed revenues.

[24] The "Opening Asset Base" figures, which are used to generate the "Return on Capital" in conjunction with *WACC*, are drawn from the AER (2007, Table 8.2).

Table 3: Unsmoothed Revenues

	2007-8	2008-9	2009-10	2010-11	2011-12	Total
Opening Asset Base	3752.83	4455.14	5107.90	5541.94	6045.69	
Return on Capital	306.38	363.72	417.01	452.44	493.57	2033.12
Return of Capital	39.78	46.19	41.17	45.60	44.95	217.69
Opex	147.63	156.76	169.18	166.99	177.30	817.86
Net Taxes Payable	0	0	0	0	0	0
Unsmoothed Revenue	493.79	566.67	627.36	665.03	715.82	3068.67

This total for "Unsmoothed Revenues" of $3068.67m is 8% lower than the AER's (2007, Table 8.3) figure of $3334.01m, due to the lower estimate for the asset beta and the higher estimate for gamma.[25]

5. Conclusions

This paper has reviewed the prescribed values for beta and gamma in the National Electricity Rules, and the principal conclusions are as follows. In respect of beta, the prescribed value of 1 in conjunction with a prescribed leverage ratio of 0.60 implies an asset beta of about 0.44; this is significantly in excess of the estimate of .30 considered to be appropriate based upon a review of the asset betas of electric utilities subject to the US regulatory regime. Furthermore, and consequent upon the AEMC's acknowledgement that the prescribed value of 1 constitutes an overestimate in the interests of erring on the side of caution, the degree of overestimation is not transparent and therefore denies interested parties any real opportunity to contest it. Furthermore, and again consequent upon the AEMC's acknowledgement that the prescribed value of 1 constitutes an overestimate in the interests of erring on the side

[25] Some upward adjustment is warranted to reflect the possibility of WACC estimation error, as discussed in section 2.3. However, we do not offer an estimate for this.

of caution, the upward adjustment of individual parameters rather than the WACC value induces excessive upward adjustment.

In respect of gamma, the prescribed value of 0.50 represents the product of the imputation attachment rate and the utilisation rate by investors, with values of about 0.80 and 0.60 respectively. In respect of the attachment rate, for which the AEMC defers to the ESC in supporting a value of 0.80, the ESC offers two arguments in support of this figure. The first argument involves reference to the dividend franking rate, which is irrelevant, whilst the second argument invokes data that implies a value of 1 rather than 0.80. It follows that the ESC and therefore the AEMC ought to favour an attachment ratio of 1.

In respect of the utilisation rate, the AEMC again relies upon the ESC, who in turn accords most weight to the dividend drop-off work of Capital Research. However, the analysis by Capital Research contains an error and correction of this error would raise the ESC's preferred figure of 0.60 to 0.75. In conjunction with an attachment rate of 1, gamma should then be 0.75 rather than 0.50. Furthermore, estimation of the utilisation rate through this methodology generates an estimate that reflects the presence of foreign investors, and this is inconsistent with the use of the Officer version of the CAPM because this model assumes that national equity markets are segmented. In the face of this inconsistency, a minimum requirement is that the results from using the Officer model in conjunction with an estimate of the utilisation rate based upon dividend drop-off studies should lie within the bounds arising from complete segmentation of national equity markets and complete integration. However, the approach described here fails this test, and is therefore wrong. Consequently, the Officer model should be combined with a utilisation rate on imputation credits that does not take account of foreign investors; this implies a utilisation rate of 1 rather than the value of 0.60 or even 0.75. In conjunction with an attachment rate of 1, gamma should then be 1 rather than 0.50 or 0.75.

If a gamma value of 1 and an asset beta of .30 are adopted, the implied equity beta is 0.75. Using an equity beta of 0.75 and gamma of 1, in substitution for the values of 1 and 0.50 respectively that are prescribed by the National Electricity Rules, the effect is to lower the allowed revenues for regulated firms. Consideration of a recent case gives rise to a reduction of 8%.

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