Response to QCA Electricity Distribution Draft Determination

Report for Ergon Energy

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Context

We have been retained by Ergon Energy Corporation Ltd (Ergon Energy) to respond to the QCA Draft Determination on the Regulation of Electricity Distribution in relation to the regulatory cost of capital.

In their original submissions to the QCA, as part of the consultation process, both Ergon Energy and ENERGEX confirmed their support for the framework that is used by the Authority to estimate an appropriate weighted-average cost of capital (WACC). In particular, both Ergon Energy and ENERGEX endorse the use of the Officer (1994) framework for consistently defining expected cash flows and discount rates (WACC), and the use of the standard Capital Asset Pricing Model (CAPM) to estimate the required return on equity.

Ergon Energy and ENERGEX also submitted that several of the parameters that are required in order to estimate the WACC cannot be precisely observed. These parameters must be estimated, often indirectly and with reference to noisy and contaminated data. For this reason, Ergon Energy and ENERGEX submitted that the impact on the WACC of using different parameter estimates should be examined and quantified. That is, since several WACC parameters cannot be precisely estimated, a regulator should examine the impact on the WACC estimate of varying these parameter estimates. The Authority has rejected this approach on advice from its consultants, preferring instead to assign a single point estimate to each WACC parameter. This approach produces a single aggregated WACC estimate which determines more than half of the revenue cap for both Ergon Energy and ENERGEX.

In this paper, we begin by responding to the Draft Determination within the QCA approach. We comment on the point estimates that have been adopted for several WACC parameters. In some cases, we examine the analysis of relevant data and the conclusions that have been drawn by the Authority and its advisors. The main focus of this paper, however, is on the relationship between the parameter point estimates that have been adopted by the Authority. In particular, we address the internal consistency between parameter estimates and the consistency of the assumptions that are applied when estimating each parameter. We document several inconsistencies and propose methods for removing these.

In the final part of the paper, we examine the reasons that have been proposed for rejecting an approach that quantifies the effect of parameter estimation uncertainty. We do not propose to alter the framework that has been adopted by the Authority, merely to quantify the effect of estimation uncertainty within this same framework. We show that our proposed analysis of uncertainty helps to achieve the regulatory objectives, increases transparency and reduces subjectivity.

Appendix 1 contains a brief summary of the issues that are addressed in this paper and the submissions for revision that are proposed by Ergon Energy. A detailed summary of each issue follows below.

Conclusions and Recommendations

In the balance of this submission, we address a range of issues. We advocate that the Authority further consider the relationships between WACC parameters, the process by which some parameters are estimated, and the effect of estimation uncertainty on the aggregated WACC.

In this section, we first consider the impact on the estimated WACC of simply changing the estimated equity beta. To the extent that single point estimates are required, we believe that there are sound reasons for using an equity beta of 1.0. Using the Authority's parameter estimates from the Draft Determination (p.83) the estimated nominal post-tax vanilla WACC is 8.33%.[1] Replacing the Authority's equity beta estimate of 0.9 with a revised estimate of 1.0 increases the estimated WACC to 8.57%.

We also argue that the statutory tax rate should be used in order to prevent a wealth transfer from the DNSPs to consumers.

We believe that there are strong reasons for using empirical estimates based on market data to estimate all WACC parameters. The best available evidence of this nature suggests that zero is the most appropriate estimate of gamma. This estimate also removes any conflict with the estimate of the market risk premium.

[1] Ergon Energy notes that the Draft Determination uses a value of 8.31%, likely due to a rounding error.

Our view is that whatever data and empirical methodologies the Authority relies on in constructing parameter estimates, the most recent information should be used. The method on which the Authority has based its past estimates of gamma (0.5) now produces an estimate of 0.35, using updated data. We advocate an estimate of zero, and note than an estimate above 0.35 would have to be carefully justified in considerable detail.

Should the Authority maintain an estimate of 0.5 for gamma, internal consistency demands that the estimate of the market risk premium (MRP) be increased. An increase in MRP to 7% (which reduces, but does not eliminate the internal inconsistency) would increase the WACC to 8.97%.

Finally, we note that these illustrations demonstrate the changes to the regulatory WACC proposed by the Authority in the Draft Determination that result from simply changing parameter point estimates. That is, if all other parameters are held at the values adopted in the Draft Determination, the illustrations above indicate the impact on the Authority's estimate of WACC. We would further recommend that the Authority should also estimate the probability that the proposed WACC will be sufficient to meet the DNSP's true cost of funds. We believe that the regulatory WACC should be set so that there is a better than even chance of the DNSP's recovering their cost of funds as:

- The effects of overinvestment are temporary and less severe to the state economy than the effects of underinvestment;
- Commercial practice suggests that new investment does not occur unless there is a greater than 50% chance of that investment recovering its cost of funds; and
- Setting a regulatory WACC that provides the DNSPs with only a 50% chance of being able to meet their cost of funds is inconsistent with the objectives of the Code, particularly providing "a sustainable commercial revenue stream which includes a fair and reasonable rate of return," ensuring the appropriate incentives exist for future investment and ensuring the continued supply of electricity.

We demonstrate below that the Authority can continue to determine the regulatory WACC without changing its procedures in any way, and then easily compute the probability that this WACC will be sufficient to recover the true cost of funds. To the extent that the probability of being able to meet the true cost of funds is set

above 50%, a commensurate increase in the regulatory WACC is required, as explained in our previous submission.

The relationship between the value of franking credits and the market risk premium

We agree with the Authority's decision to continue to use the WACC framework developed by Officer (1994). We note that within this framework, there is a deterministic mathematical relationship between the value of franking credits (gamma) and the market risk premium (MRP). If franking credits are assumed to be of value to investors such that the firm's revenue requirement is reduced, this same value must also be reflected in the estimate of MRP.

It is inconsistent to assume that franking credits are valuable such that they reduce corporate cost of equity, but then ignore them when estimating the market risk premium.

Thus, the Authority's estimate of MRP = 6% should include the value of franking credits. This seems unlikely given that the data sources used to justify that estimate consist of dividends and capital gains only and the Authority has made no mention of any adjustment for the value of franking credits. It can also be shown (see Officer, 1994) that this all-inclusive interpretation of the MRP implies that the MRP from dividends and capital gains is only 3.9%, which is dramatically lower than any empirical estimate that could be entertained.

Also, note that if the MRP estimate of 6% is assumed to include the value of franking credits, and the risk-free rate is 5.4%, the total return required on the market portfolio is 11.4% ($r_f + MRP = 5.4\% + 6\%$). If $\gamma = 0.5$, Officer (1994) shows that equity investors receive about 82% of their return from dividends and capital gains, and 18% from franking credits. Thus, the market portfolio must generate a return of about 2.0% from franking credits.

If we further assume that franking credits once distributed are valued at 62.5% of face value (consistent with the Draft Determination), the yield of franking credits must be 3.4% $\left(\frac{2.0\%}{0.625}\right)$. That is, the average firm in the market portfolio must distribute franking credits with face value of 3.4% of the stock price. At a corporate

tax rate of 30%, with every $1 of dividends paid, franking credits of 43 cents $\left(\frac{\tau}{1-\tau}=\frac{0.3}{1-0.3}\right)$ can be distributed.

Therefore, to generate a franking credit yield of 3.4%, the average firm must generate a dividend yield of 7.8% $\left(\frac{3.4\%}{0.43}\right)$. That is, a $100 stock pays a dividend of $7.80, with franking credits of $3.40, if fully franked. This franking credit is then worth $2.00 to the relevant investor. To the extent that not all dividends are fully franked, the aggregate dividend yield on the market portfolio would have to be even higher than 7.8%. Since the observed dividend yield on the market portfolio is an order of magnitude less than this, the assumptions of $\gamma = 0.5$ and MRP = 6% are dramatically inconsistent with observed market data.

The implication of setting γ = 0.5 implies that half of all corporate tax paid is received and valued by investors in the form of franking credits. This implies that after-company tax returns are substantially increased. Indeed this increase can be deterministically quantified, as in Officer (1994). **The problem is that such a large value for franking credits simply cannot be accommodated within a MRP estimate of 6%. Thus the assumed value of franking credits must be reduced or the estimate of MRP must be increased, or both.**

Estimating gamma in the presence of foreign investors

In the Draft Determination, the Authority notes that the value of franking credits, gamma, depends on the rate at which franking credits are distributed and the rate at which they are valued, once distributed. We agree with the Authority's assessment of the components of the value of franking credits.

Of course, it is well recognized that franking credits are likely to be valued differently by different investors. It is impossible to observe the value that any investor, or group of investors, places on franking credits. Thus, there are two ways to proceed:

1. Assume the identity of the relevant investor type and assume the value that type of investor places on franking credits once distributed; or

2. Make no assumption about the relevant investor type and try to infer the value of franking credits from market data.

The Authority, via its consultant, endorses the first approach. In the Draft Determination (p. 105), the Authority states that, "introducing the concept of a foreign investor is inconsistent with a domestic CAPM model," and that there is, "a strong case that the value of the utilization rate in the context of the Officer CAPM should be one, for consistency with the domestic framework of the model." Moreover, in the consultant's report, Lally (2004, p. 35) rejects the use of any empirical estimate "that is potentially significantly influenced by the presence of foreign investors" as this "introduces an inconsistency into the model." He summarises (p. 42) that the empirical evidence reflects "the presence of foreign investors. By contrast, the use of a domestic CAPM such as the Officer model implies that national share markets are segregated…consequently an estimate for the utilization rate of close to one is appropriate." That is, the available market evidence should be ignored and replaced with an assumed value to preserve theoretical consistency. The value of franking credits should be assumed rather than estimated. This implies that we should not estimate γ as it is, but as it would be if Australia were perfectly segmented from world capital markets.

We submit that this approach should be rejected for two reasons. First, the standard CAPM has many other theoretical problems, but is still the industry standard in practice. Many of the CAPM's assumptions are not supported in practice. It is clear that not all investors can borrow and lend unlimited amounts at the risk-free rate. Should we omit from consideration all investors who cannot borrow and lend at the same rate as the government? It is clear that not all investors hold the market portfolio. Should we omit from consideration all investors who own anything but mutual funds? The CAPM is a one-period model. Should we omit from consideration all investors who consider reinvestment risk? If investors who violate these assumptions remain in consideration, why not continue to consider foreign investors? Second, the Authority's estimates of other WACC parameters reflect the activity of foreign investors. Consistency requires that if empirical estimates of the value of franking credits are to be rejected in favour of value that is assumed to apply in the absence of foreign investors, the same must be done for all other WACC parameters. This requires that the asset beta, risk-free rate, and market risk premium be recomputed to reflect the values they would take in the absence of

foreign investment. It is likely that the supply of foreign capital has reduced the risk-free rate and market risk premium, for example.

In summary, we reject the approach of assuming a value of franking credits in order to preserve the theoretical consistency with an imperfect model, rather than using an estimate based on market data. If, however, this approach *is* to be applied to the estimate of gamma, consistency demands that it must also be applied to all other WACC parameters.

The second approach is to make no assumption about the relevant investor type and try to infer the value of franking credits from market data. All empirical studies, including Cannavan, Finn and Gray (2004) adopt this approach. No discussion of marginal, average, or aggregate investors is required. All of these approaches imply seek to estimate the value of franking credits as it is, rather than as it would be under some theoretical assumption. Having obtained an estimate, one can pursue an academic discussion about what theoretical settings might produce that result. But none of this is required to produce an estimate of the value of franking credits using market data, in exactly the same way that other parameters are estimated. For example, no discussion of which investors should be included, which should be ignored, and the process by which the market clears is entertained when estimating MRP or beta. Consistency demands that the same should apply when estimating gamma.

We recommend that all WACC parameters should be estimated with reference to market data. No parameter value should be assumed. We recommend that the Authority endorse this approach and explicitly reject the use of a theoretical assumed value of franking credits as advocated by its consultant.

If the Authority follows this recommendation[2], it must then state the reasons for which piece or pieces of evidence form the basis for its *estimate* of gamma. **We note that only one paper uses data subsequent to the important change in tax laws in 1997 and is peer-reviewed published in a leading journal. The recommendation from that paper is that gamma should be set to zero.**

[2] The Authority has already determined that although "Lally made a strong case" his recommendation would not be explicitly followed as a way of (p. 105) "achieving compromise over a controversial issue."

Hathaway and Officer (2004): Updated analysis

To the extent that the Authority's estimate of $\gamma = 0.5$ can be tied to empirical estimates, it appears to be based on the aggregate tax statistics data that was analysed by Hathaway and Officer (1998, revised 2002). In that paper, the authors state that the "access factor is 80%" and that "about 60% of distributed credits are being redeemed." This same evidence was used as the basis for the "reasonable assumption" of 0.5 that appears in Schedule 6.1 of the Code. Moreover, these estimates match (within rounding error) the values of 80% and 62.5%, respectively, used by the Authority.

If this is the preferred form of empirical evidence, the most recent available data should be used in the current determination. Hathaway and Officer (2004) contains updated data and more detailed and careful analysis. Their conclusion is that, "the access factor is 71% and about 50% of distributed credits are being redeemed. Overall, about 35% of company tax is actually a pre-payment of personal tax."

If this is the empirical methodology that is preferred by the Authority, a revised estimate of 0.35 must be used for gamma. If not, transparency requires that the Authority should state what method is preferred, and why.

Effective and statutory tax rates

In the Draft Determination, the Authority correctly notes that (p. 105) "in determining the tax rate to be applied, there are broadly two alternatives: the statutory rate; or an effective rate, which adjusts the statutory rate for both the timing of tax payments and permanent differences between the statutory rate and the actual rate." The Authority recognizes that Ergon Energy and ENERGEX support the use of a statutory tax rate, but does not state or discuss any of the arguments contained in their submissions. The Authority then concludes (p. 106) that, "it is important that the DNSPs are compensated for the tax paid during any particular year. It is also important that the tax paid reflects the actual tax paid and not simply the statutory rate of tax. If the effective tax rate is below the statutory rate, the DNSPs will receive a benefit at the expense of consumers."

Thus, the primary concern of the Authority is that using the statutory rate will result in the distribution businesses receiving revenue to which they are not entitled. That is, the Authority, is concerned about a wealth transfer from consumers to the

businesses. In fact, the reverse is true. Using the effective rate amounts to a wealth transfer from the businesses to consumers. We agree that the Authority must guard against causing such wealth transfers through the exercise of its discretion. However, the way to avoid such a wealth transfer is to adopt the statutory, rather than effective, tax rate.

Consider a year in which a distribution business pays no tax. The reason it pays no tax is that it has sufficient deductions and tax loss carry-forwards. These tax loss carry-forwards are (or should be) an asset. They have resulted from taxable revenues falling short of deductible expenses in past years. This asset should have value in that it will reduce tax payments in subsequent years. However, in a regulatory environment in which tax compensation is based on the effective rate, the value of this asset is destroyed. In any given year, after-tax profit is the same whether tax of 30% or 0% was paid. Thus, the value of tax loss carry-forwards is zero – the business is no better off with or without tax credits. Thus, such a regulatory scheme destroys the value of one of the business's assets.

If such a firm operated in an unregulated setting, its tax loss carry-forwards would be valuable. Thus, a regulatory environment that uses effective tax rates produces an outcome that differs from the outcome in a commercial setting. This runs counter to the principles of regulation and would cause competitive neutrality issues in a setting in which regulated and unregulated firms compete.

For these reasons, we submit that the tax compensation should be based on the statutory tax rate to preserve equity between customers and the distribution businesses and to mimic the outcome of a commercial market.

Equity beta adjustment

The Authority has adopted the recommendation of its consultants, the Allen Consulting Group (ACG), in setting the equity beta at 0.9. In its report, ACG concludes that the appropriate equity beta for the average Australian electricity distribution business, geared to 60%, is 1.0. We agree with this conclusion and have reached a similar conclusion based on a wide range of independent analysis

methods[3]. We believe that there is substantial evidence to corroborate this as the most appropriate point estimate.

ACG then note that ENERGEX and Ergon Energy differ from the average Australian electricity business in three respects:

1. **ENERGEX and Ergon Energy have higher operating leverage.**

We agree with ACG that it is well-accepted that, other things equal, firms with higher operating leverage have higher systematic risk. Indeed this view is so commonplace that it appears in standard textbooks[4].

ACG then define an "operating cost ratio" and estimate this value for a number of Australian energy distribution businesses. They show that Ergon Energy and ENERGEX have higher operating cost ratios than other comparables. However, this ratio does not measure operating leverage, it measures margin. It is based on earnings relative to cash operating costs. Operating leverage is based on the relative values of fixed and variable costs.

The ACG report concludes that the higher operating leverage of Queensland electricity distributors increases their systematic risk, but this increase is more than offset by the reduction in systematic risk resulting from the revenue cap discussed below. However, it does not quantify either of these effects which operate entirely independently.

However, we can derive the set of assumptions that implicitly underlie this conclusion and apply a reasonableness test. We conclude that these implicit assumptions understate the positive impact of operating leverage and overstate the negative impact, if any of the revenue cap, on the measurement of systematic risk. In addition, given the estimation error involved in estimating WACC parameters, it is difficult to understand how such a precisely quantified reduction in the equity beta (0.1 to 0.9 in comparison to interstate distributors) can result

[3] Strategic Finance Group (SFG Consulting Pty Ltd.) (2005). The Equity Beta of an Energy Distribution Business Draft Report Prepared for AGL; and Strategic Finance Group (SFG Consulting Pty Ltd.) (2005). The Equity Beta of an Electricity Distribution Business Draft Report Prepared for ETSA Utilities.

[4] See for example, Brealey, R. A., & Myers, S. C. (2000). Principles of Corporate Finance (6th ed.). Boston: Irwin McGraw-Hill.

from a qualitative analysis of operating leverage and the impact of the revenue cap.

2. ENERGEX and Ergon Energy operate under a revenue cap rather than a price cap.

ACG argue that, other things equal, a pure revenue cap reduces systematic risk relative to a pure price cap. The equity beta is well-known to depend on:

- The correlation between the returns of the firm and the broad market;
- The volatility of firm returns; and
- The volatility of market returns.

The form of regulation influences the first two components. The volatility of market returns is considered to be constant.

First, note that relative to firms that operate under a price cap, firms that operate under a revenue cap:

- Do better when sales volume is low (revenue is fixed and does not decline with volume); and
- Do worse when sales volume is high (revenue is fixed and does not increase with volume).

Since electricity demand is positively correlated with economic growth and stock market returns, this implies that a revenue cap reduces the correlation between firm and market returns, relative to a price cap. We agree with the ACG analysis that, other things equal, this has a downward effect on the equity beta.

However, a revenue cap can substantially increase the volatility of firm returns. If actual volume differs substantially from forecast volume, firm returns can vary substantially. For example, the substantial under-estimation of future volumes, and the operation of a revenue cap, recently had a dramatic impact for NSW electricity distribution businesses.

Thus, a revenue cap is likely to reduce correlation with market returns, but increase the volatility of firm returns. One of these effects reduces equity beta, and one increases equity beta. It is not clear which of these effects dominates, and quantification of these effects is difficult.

3. **Revenue cap revisions/Demand triggers.**

The QCA has proposed to revise the revenue cap in response to certain demand triggers. Relative to a pure revenue cap, this mechanism has the effect of:

- Increasing returns when volumes, economic growth and market returns are high; and
- Reducing returns when volumes, economic growth and market returns are low.

Thus, relative to a pure revenue cap, the effect of the demand triggers is to increase correlation with market returns. This has an upward influence on the equity beta. Of course, it also reduces the likelihood of extreme outcomes (such as the recent NSW experience.) Overall, the effect of the demand triggers is to make a pure revenue cap operate more (but not exactly) like a price cap.

In summary:

- We agree with the ACG conclusion that the appropriate equity beta (re-geared to 60%) for the average Australian electricity distribution business is 1.0.
- We agree with the ACG conclusion that higher operating leverage leads to higher equity betas, other things equal.
- The implicit assumptions involved in the ACG analysis understates the positive impact on systematic risk of higher operating leverage and overstates the resulting effects, if any on revenue cap.
- We note that the operation of a revenue cap, relative to a price cap reduces the correlation between firm and market returns, but increases the volatility of firm returns. The net impact on equity beta is difficult to quantify.
- We note that the demand trigger provisions make the revenue cap operate more (but not exactly) like a price cap. This makes Ergon Energy and ENERGEX more like the average Australian energy distribution business.

For these reasons, we conclude that there are clear, well-accepted and unambiguous reasons for increasing the equity beta for Ergon Energy and ENERGEX relative to comparable Australian firms. We are also able to quantify this effect using market data.

There are other reasons that may warrant a reduction in the equity beta estimate. However, these are impossible to quantify and there are several off-setting effects such that the net directional effect and magnitude are unclear.

Therefore, we conclude that the reasons for increasing the equity beta (relative to the average comparables) are better justified than the reasons for decreasing it. Therefore, we propose that an equity beta of at least 1.0 should be used. Given the imprecision with which equity betas are estimated, we suggest that any proposed adjustment to the estimate for the average comparable firm suggests a level of precision that is unwarranted. Hence, we conclude that 1.0 is an appropriate estimate of the equity beta for Ergon Energy and ENERGEX.

Implied beta estimates from previous submissions

In our submission on behalf of Ergon Energy and ENERGEX as part of the consultation process, we submitted that assigning a point estimate to some WACC parameters implies a degree of statistical precision that is unwarranted. For example, the Authority reports some indirectly and imprecisely estimated parameters to three decimal places. Our recommendation was that estimation uncertainty should be recognized by providing an economically reasonable range, rather than a single point estimate, for some parameters.

This has led ACG, in its report to the QCA to mis-interpret the implications of our approach on the estimate of the equity beta. We demonstrate that the ranges we have used for a number of WACC parameters are all perfectly consistent with a range for the equity beta that is centered around 1.0. Thus, **our earlier submission is in no way inconsistent with our conclusion that an appropriate point estimate of the equity beta is 1.0.**

Recognizing the uncertainty in WACC parameter estimates

In their original submissions to the Authority, as part of the consultation process, Ergon Energy and ENERGEX proposed that certain WACC parameters cannot be precisely estimated, and that an economically reasonable range, rather than a single point estimate, should be used. Standard simulation techniques can than be used to quantify the effect that this has on the estimated WACC.

The Monte Carlo simulation approach was rejected by the Authority on the advice of its consultants for the following reasons:[5],

- At present, regulators only need to form a view on the inputs for the CAPM and WACC parameters. The use of a Monte Carlo method would also require the regulator to form a view on the probability distribution of the estimator for each input;
- Most regulators would consider that the parameter inputs they adopt in determining the WACC already contain a degree of conservatism. Accordingly, if Monte Carlo simulation were to be used, it would need to be based on unbiased estimates of the parameters and not on inputs that already contained an element of conservatism.
- The Authority also notes that no evidence has been presented to suggest that this technique has been used by other regulators.

The simulation approach is not a proposal to reject the current framework in favour of a new and untested approach. It simply involves examining the effect of estimation errors within the current framework. That is, the question is not one of which framework to use, but one of whether to recognize or ignore estimation errors, *within the existing framework*. Ignoring estimation uncertainty does not make it go away. Estimation error is economically important, such that it is difficult to see how the objectives of the Code can be met by ignoring it.

The Code requirements include the provision of "a sustainable commercial revenue stream which includes a fair and reasonable rate of return" having regard to the "weighted average cost of capital applicable to the relevant network service." ENERGEX and Ergon Energy have proposed the use of standard statistical techniques to determine the probability that a particular regulatory WACC is sufficient to cover the DNSPs true cost of funds. This can be used by regulators to directly address the Code requirements. Indeed, it is difficult to see how the requirements of the Code are best met by ignoring this information.

Moreover, the ACG contention that regulators already use "conservative" parameter estimates necessarily requires that they have established a range and then selected a value towards one end. If not, in what sense can a point estimate be considered to

[5] See ACG report and QCA Draft Determination.

be "conservative"? Given that a range has been identified, transparency demands that it should be stated. The proposed simulation approach simply defines a range for each parameter, and then uses standard statistical techniques to determine the impact of this uncertainty on the estimated WACC.

We also note that standard Monte Carlo simulation techniques *have* been used in relation to the estimation of WACC parameters in Australian regulatory settings. Indeed the Authority itself has used a similar methodology (in relation to estimation of benchmark capital structure) in the BRIA and GAWB determinations. The Authority also recognizes Monte Carlo simulation as an appropriate technique in relation to capital structure estimation in their response to the Lally Report in the DBCT Determination where they state (p.177) that an optimal capital structure can be determined "by using simulation techniques," describing this as "a more sophisticated approach." Moreover, the Authority's engineering consultants have used simulation modeling extensively and this approach is referred to in three separate places in the DBCT Draft Determination alone.

Finally, it should be noted that **the Authority can easily recognise the effect of parameter estimation uncertainty squarely within its current framework and procedures.** The Authority can continue to select point estimates for each parameter and to estimate a point estimate for the WACC. The simulation approach can then be used to quantify the probability that this regulatory WACC provides the business with a return that is sufficient to meet its cost of funds. The Authority has already identified parameter ranges (in order to consider that a particular point estimate is "conservative") and the simulation approach is straightforward to implement. Thus, the approach is not costly to implement and we would be happy to assist the Authority in this regard. Moreover, quantifying the probability that the assigned regulatory WACC is sufficient to meet the DNSPs' true cost of funds is central to the implementation of the objectives spelled out in the Code. For example, a regulatory WACC that provides a 75% chance of meeting the true cost of funds is likely to be sufficient to provide "a sustainable commercial revenue stream," but a WACC that provides only a 25% chance does not.

1. Gamma and MRP

1.1. Overview

It is standard to measure equity returns as dividends plus capital gains. Indeed all known data sources measure equity returns in this way. In a dividend imputation system, however, there is potentially a third component of returns—franking credits. To the extent that franking credits are valued by the relevant investor, this value must be added to the standard return measure. Officer (1994) makes this point in the paper that develops the cost of capital framework that is used by Australian regulators. This also applies, importantly, to the estimate of the market risk premium (MRP). If the MRP is estimated using returns that are measured in the standard way, the assumed value of franking credits must be added to compute a grossed-up MRP, which can than be used in the CAPM.

In this paper, we review the mathematically deterministic relationship between the assumed value of franking credits and the estimate of MRP. This is the framework developed by Officer (1994). Our focus in this paper is not on how to best estimate the value of franking credits or the market risk premium, but on the relationship between them. If franking credits are assumed to have value, the MRP must reflect this. **It is inconsistent to assume that franking credits are valuable such that they reduce corporate cost of equity, but then ignore them when estimating the market risk premium.** In this section, we do not propose anything new. We simply examine the deterministic mathematical relationship between the value of franking credits and MRP that was first addressed by Officer (1994).

It is standard in Australian regulatory practice to use an estimate of 6% for the MRP. This estimate is based on various data sources all of which consider dividends and capital gains only. Officer (1994) shows that, the value of franking credits must be added to this estimate. If the value of franking credits (γ) is set to zero, no adjustment to the estimate of MRP is required. This is consistent with the notion that franking credits are of no value to the relevant investor such that the Australian imputation system does not affect the equilibrium cost of capital of Australian firms. If, however, a positive value is used for γ, an adjustment to the MRP is required to reflect the value of franking credits. Using parameter estimates of $\gamma = 0.5$, and MRP = 6%, and a risk-free rate of 5.41%, as in the Draft Determination, we demonstrate that including the value of these franking credits increases the MRP to 8.4%. **That is, a MRP of 8.4% is internally consistent with $\gamma = 0.5$, and the other**

parameters used in the Draft Determination. A MRP estimate of 6% implies that no adjustment has been made for the value of franking credits, and is therefore consistent with $\gamma = 0$.

An alternative interpretation is that the 6% estimate of the MRP already includes the value of franking credits. This is unlikely, given that standard data sources used to justify that number, consist of dividends and capital gains only. Moreover, such an interpretation can be immediately rejected in that it implies that the MRP from dividends and capital gains is only 4.0%, which is dramatically lower than any empirical estimate that could be entertained. Finally, we demonstrate that within the Officer (1994) framework, if $\gamma = 0.5$, MRP = 6% and the risk-free rate is 5.72%, a fully-franked dividend yield of 7.8% is required on the market portfolio. This is because the assumed value of γ can be used to derive the rate at which franking credits are distributed which in turn determines the required dividend yield. Since the required dividend yield is an order of magnitude greater than the observed dividend yield on the market portfolio, it provides further evidence for rejecting the interpretation that a 6% MRP includes the value of franking credits.[6]

Our conclusion is that, estimates of 0.5 for gamma and 6% for MRP are inconsistent with the very cost of capital framework that is employed.

Consistency can be restored in one of two ways:

Adjusting Gamma to restore internal consistency

Setting gamma equal to zero is consistent with the most recent empirical evidence[7]. This also implies that the MRP of 6% is due entirely to dividends and capital gains. This is also consistent with the available empirical evidence.

Adjusting MRP to restore internal consistency

Maintaining the assumption that $\gamma = 0.5$, and using the other parameter values of the Determination, and the empirical evidence that dividends and capital gains generate a MRP of 6%, a grossed-up MRP of 8.4% must be used when estimating the required return on equity.

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[6] This paper addresses the relationship between γ and the MRP. Thus, we are concerned with *market* returns and the *market* dividend yield, *not* returns and yields of particular companies.

[7] See for example, Cannavan, D., Finn, F., & Gray, S. (2004) "The Value of Dividend Imputation Tax Credits in Australia," *Journal of Financial Economic*s, 73, 167-197.

Which of these options should be pursued could be determined with reference to other data, such as observed dividend yields. Our focus here is on the *internal* consistency between the parameters that have been used to compute the WACC.

1.2. Interpretation of the Officer (1994) Framework

Officer (1994) develops a framework for consistently defining the cost of capital and cash flows in a dividend imputation tax system. This framework, and particularly the definitions of weighted-average cost of capital (WACC), have been adopted by Australian regulators.

Officer (1994) presents definitions of WACC on a before and after corporate tax basis. In this section, we focus on his first definition of after corporate tax cash flows and WACC, for ease of exposition. The same arguments apply regardless of which definition of WACC is used and whether franking credits are incorporated in the WACC or the cash flows. Our points relate to the internal consistency of various parameter estimates. Using an estimate of γ in defining cash flows that is inconsistent with the estimate of MRP used to estimate WACC is just as problematic as if both are incorporated in the WACC estimate. Separating inconsistencies may make them harder to spot, but does not eliminate their effect. Moreover, Officer demonstrates that all of his WACC/cash flow definitions produce identical results so long as they are applied consistently. For these reasons, our illustration is based on his after corporate tax definition (i) (p. 6).

Officer begins by defining after corporate tax cash flows as $X_o(1-T)$, consistent with the standard textbook treatment. Here X_o represents operating cash flows and *T* represents the relevant corporate tax rate. The definition of the after corporate tax discount rate that is consistent with this definition of cash flows is defined in Equation (7) as:

$$r_i = r_E \frac{S}{V} \frac{1-T}{1-T(1-\gamma)} + r_D \frac{D}{V}(1-T)$$

where:

r_i is the weighted-average cost of capital,

r_E is the return on equity capital required by investors,

r_D is the return on debt capital required by investors,

$\frac{S}{V}$ is the proportion of equity finance,

$\frac{D}{V}$ is the proportion of debt finance,

T is the corporate tax rate, and

γ is the value of franking credits.

In this framework, r_D is the return that debtholders require (before personal tax) to compensate them for the risk involved in lending to the firm. Since these interest payments are tax deductible at the corporate level, the firm's after-tax cost of debt capital is $r_D(1-T)$. That is, if debtholders require a return of 7% and the corporate tax rate is 30%, the firm's after-tax cost of debt is 4.9%. Of the 7% required return, 4.9% is provided by the firm and 2.1% is effectively provided by government via the tax system.

The same applies to the cost of equity. Here, r_E is the return that equityholders require (before personal tax) to compensate them for the risk involved in owning shares in the firm. In the Australian regulatory framework, and in commercial practice, r_E is usually estimated using the Capital Asset Pricing Model (CAPM). This provides an estimate of the return that the equityholders require. As is the case for debt, there is a difference between the investors' required return and what the firm must pay. Again, a government tax subsidy may be relevant. In particular, equityholders require a total after corporate tax return of r_E. This return potentially has three components: dividends, capital gains, and franking credits. The firm is responsible for generating dividends and capital gains. Franking credits are paid by government via the tax system. Officer's WACC formula quantifies the proportion of r_E that must be generated by the firm, $\frac{1-T}{1-T(1-\gamma)}$, and the proportion that is paid by government via the imputation tax system, $\frac{\gamma T}{1-T(1-\gamma)}$. Thus, the firm's after-tax cost of equity capital is $r_E \frac{1-T}{1-T(1-\gamma)}$. Indeed this is the key contribution of Officer (1994). He derives the proportion of the required return on equity that must be generated by the firm via dividends and capital gains.

Of course, this point is well recognized in the academic and practitioner literature. Copeland, Koller and Murrin (2000, p. 134) for example note that WACC is "the opportunity cost to all the capital providers weighted by their relative contribution to the company's total capital." They also note (p. 134-5) that, "the opportunity cost to a class of investors equals the rate of return the investors could expect to earn on other investments of equivalent risk. The cost to the company equals the investors' costs less any tax benefits received by the company (for example, the tax shield provided by interest expense)." In a dividend imputation system, the government may also subsidize equity returns via the payment of franking tax credits.

In the detailed numerical example in the Appendix, Officer (1994, pp. 11 - 17), Officer shows how the CAPM can be used to derive a required return on equity of 17.7% and that the firm's cost of equity is:

$$r_E \frac{1-T}{1-T(1-\gamma)} = 17.7\% \frac{1-0.39}{1-0.39(1-0.5)} = 13.4\%$$

using the parameter values assumed in the example. That is, the imputation tax system has reduced the firm's cost of equity capital by 4.3% in this case. The value of this reduction in the firm's cost of equity is capitalized into the stock price. In this case, the value of equity increases from $120 million (under a classical tax system) to $158.361 million (under an imputation system in which $\gamma = 0.5$). Officer demonstrates that **the equityholders' required return does not change. What changes is the proportion of this return that must be generated by the firm.** In a classical system, the firm had to generate *all* of this return. In an imputation system, the government funded some of this required return (in fact 4.3%) reducing the firm's after tax cost of equity from 17.7% to 13.4%. That is, the CAPM tells us what return equityholders require (a return that is measured after company tax but before personal tax) and Officer (1994) derives the proportion of that return that must be generated by the firm, $\frac{1-T}{1-T(1-\gamma)}$.

1.3. The QCA Position: Market risk premium = 6%

In the Draft Determination[8], the Authority has adopted an MRP of 6%. The Authority (2004, p. 97) notes that regulators have had regard to a number of different methodologies when estimating the market risk premium, including the range provided by a long-term historical average of the premium of equity returns over bonds in the Australian market, alternative methodologies for interpreting historical information, ex-ante estimates and regulatory precedent. The Authority (2004, p. 98) further notes that, "in the past the Authority has used a market risk premium of 6% primarily on the basis of an historical averaging methodology," and that, "based on a survey of a range of different estimation methodologies" this estimate is reasonable. Thus, **the Authority recognises that the primary source of data is the historical average observed MRP, but that other means of estimation are also available.**

The standard application of all of these approaches is to compute an estimate based on dividends and capital gains only. Historical data measures returns as cash dividends plus stock price changes adjusted for capitalisation changes. Survey data is also posed in terms of dividends and capital gains and sometimes respondents are asked only to predict the future level of a broad market index. Ex-ante models posit that expected returns are the sum dividend yields plus capital gain. If gamma is zero, there are no other components of the market return. If gamma is greater than zero, the market return consists of dividends, capital gains, and the value of franking credits. This third component must be included in the MRP if gamma is set to a positive value. It is excluded in the 6% estimate that comes from the standard analysis of the usual data sources. Whereas this issue has not been explicitly addressed by the Authority, it did note in the Dalrymple Bay Coal Terminal Draft Access Undertaking (p. 176) that conceptually the MRP is based on the "expected rate of return on the Australian market portfolio (inclusive of imputation credits to the extent that they are usable.)" Some other Australian regulators have more explicitly recognized the relationship between these parameters.

For example:

- In the 2001 Electricity Distribution Price Review Draft Decision (2000, pp. 156 - 158), the Essential Services

[8] Queensland Competition Authority (2004) "Draft Determination Regulation of Electricity Distribution".

Commission adjusted the dividend yield used in estimating the ex-ante premium to reflect the assumed value of franking credits.

- In the Review of Gas Access Arrangements Draft Decision (2002, p. 157), the Essential Services Commission used Mercer Investment Consulting (MIC) to prepare an estimate of the ex-ante premium. MIC noted that their standard practice was to ignore the value of franking credits when estimating the MRP. The Commission then assessed the impact on their estimate if an assumed value of franking credits were included.
- In the Review of Gas Access Arrangements Final Decision (2002, p. 324), the Essential Services Commission noted that, "its assumption about the value of franking credits requires an upward adjustment to the measure cash equity premium to add back the non-cash value of franking credits since 1987."
- In the Draft 2005 - 2010 Electricity Distribution Price Determination, the Essential Services Commission of South Australia (2004, p. 179) explicitly recognizes this point by adding an estimate of the "non-cash value of franking credits for the period since 1987" to historical values of dividends and capital gains.

That is, standard data sources estimate the MRP based on dividends and capital gains only. Some Australian regulators have correctly recognized that, to the extent that franking credits have any value to the relevant investor, this value must be added to the estimate of MRP.

In the remainder of this section, we quantify the size of the adjustment that is required to preserve internal consistency among the WACC parameters. Some Australian regulators have recognized, at a conceptual level, that the standard estimate of MRP must be increased to reflect the value of franking credits. However, none have actually made any such adjustment. All use the same estimate of MRP as do other regulators who ignore the impact that franking credits have on MRP entirely. We demonstrate below that the required adjustment to the MRP can be defined mathematically as a function of the WACC parameters. For standard regulatory parameter estimates, the adjustment that is required to preserve internal consistency is substantial.

If the required adjustment were insignificant, it could be recognized as a conceptual issue, but then ignored when quantifying WACC parameter estimates. For standard regulatory parameter estimates, however, the required adjustment is substantial. This requires that either:

- The estimate of MRP should be adjusted to *properly* reflect the value of franking credits, consistent with the assumed WACC parameters, not simply recognized "conceptually", or
- Other WACC parameter estimates should be changed, such that the mathematically required adjustment to MRP is reduced.

1.4. The relationship between gamma (γ) and MRP

1.4.1. The cost of equity capital

Australian regulators follow commercial practice in using the CAPM to estimate the return required by equityholders. This is the equilibrium return that they require on their equity investment after corporate tax but before personal tax. This return is defined as:

$$\hat{k}_e = r_f + \left(\hat{k}_m - r_f\right)\beta_e$$

where: $\hat{k}_e$, $\hat{k}_m$ = the expected returns on equity and the Australian market portfolio respectively; r_f = the risk-free rate; and β_e = the firm's equity beta.

Officer (1994) shows that the market return should include the value of franking credits such that the expected return on equity is the total return, inclusive of dividends, capital gains and franking credits. If market returns are defined in terms of dividends and capital gains only, Officer (1994, eq. 18) shows that the value of franking credits must be added back to obtain the total after corporate tax market return. The CAPM then yields the total required return on equity, part of which must be provided by the firm and part of which is provided by government via franking credits.

1.4.2. Return to equityholders under dividend imputation

Under a dividend imputation system, the expected return to equityholders comprises a return from dividends and capital gains, plus the benefit of franking credits, which can be expressed as:

$$\hat{k}_e = \hat{k}_e\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right] + \hat{k}_e\left[\frac{\gamma\tau}{1-\tau(1-\gamma)}\right]$$

where: $\hat{k}_e$ the total required return on equity, which may be estimated using the CAPM, so long as the MRP includes the value of franking credits; τ = the corporate tax rate; and γ = the value of franking credits to the relevant investor as a proportion of franking credits created. This specifically recognizes that part of the return required by equityholders is provided by the firm via dividends and capital gains and part is provided by government via franking credits.

On the right hand side of the equation, the first term represents the return on equity from dividends and capital gains, while the second term represents the return on equity from the benefits of dividend imputation. Allocating the total return to equityholders into these two components we can say that:

$$\text{Proportion of return from dividends and capital gains} = \left[\frac{1-\tau}{1-\tau(1-\gamma)}\right]$$

$$\text{Proportion of return from dividend imputation} = \left[\frac{\gamma\tau}{1-\tau(1-\gamma)}\right]$$

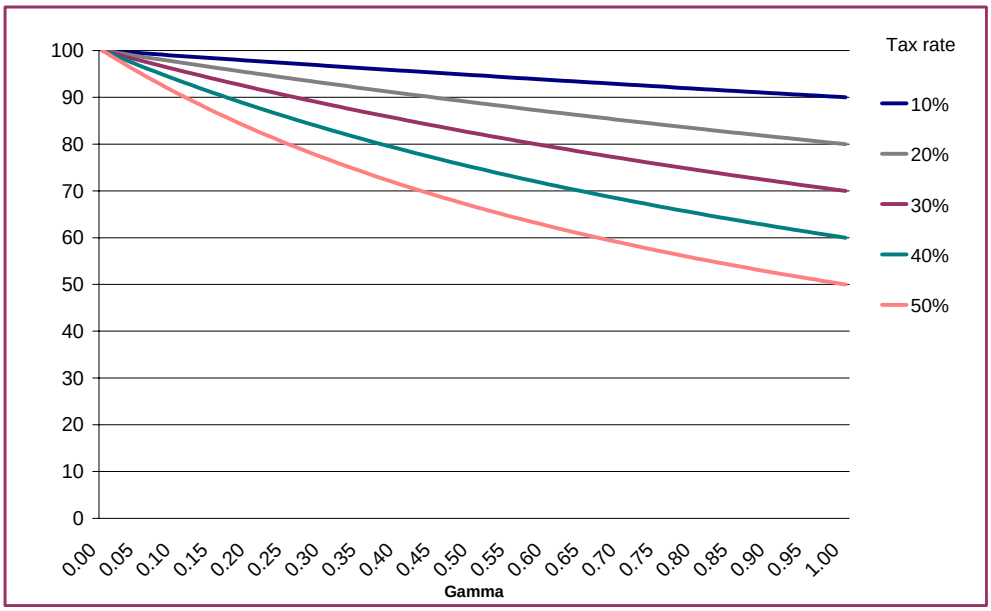
We note above that Officer (1994) derives these expressions in the same paper that develops the cost of capital framework used by Australian regulators.

The following Table and Figure present these proportions for alternative values for the corporate tax rate and the value of franking credits. **For example, with a corporate tax rate of 30% and gamma = 0.5, 82% of the total return required by equityholders is comprised of dividends and capital gains, while 18% of the total return consists of franking benefits.**

Table: Proportion of returns to equityholders from dividends and capital gains versus franking credits under alternative values for the corporate tax rate and the value of franking credits (gamma)

Tax rate	Gamma				
	0.00	0.25	0.50	0.75	1.00
Proportion of returns attributable to dividends and capital gains (%)					
10%	100	97	95	92	90
20%	100	94	89	84	80
30%	100	90	**82**	76	70
40%	100	86	75	67	60
50%	100	80	67	57	50
Proportion of returns attributable to franking credits (%)					
10%	0	3	5	8	10
20%	0	6	11	16	20
30%	0	10	**18**	24	30
40%	0	14	25	33	40
50%	0	20	33	43	50

Figure: Proportion of return on equity from dividends and capital gains under alternative tax rates and the value of franking credits (gamma)



1.4.3. Franking credits and the MRP

Recall that implementation of the CAPM in this setting requires a market risk premium $\left(\hat{k}_m - r_f\right)$ that includes the value of franking credits. This assumption, combined with the discussion in sections 4.4.1 and 4.4.2 implies that we can derive an expression for the market risk premium. Combining the equations in sections 4.4.1 and 4.4.2 we have:

$$r_f + \left(\hat{k}_m - r_f\right)\beta_e = \hat{k}_e\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right] + \hat{k}_e\left[\frac{\gamma\tau}{1-\tau(1-\gamma)}\right].$$

For a firm with average systematic risk (β_e = 1, representative of the market portfolio), the cost of equity capital is:

$$r_f + \left(\hat{k}_m - r_f\right) = \hat{k}_e\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right] + \hat{k}_e\left[\frac{\gamma\tau}{1-\tau(1-\gamma)}\right].$$

Consider the second term on the left-hand side of the equation, the market risk premium $\left(\hat{k}_m - r_f\right)$. This term represents the equityholders' compensation for bearing systematic risk, and includes the value of franking benefits. These franking benefits are quantified in the second term on the right-hand side of the equation, $\hat{k}_e\left[\frac{\tau\gamma}{1-\tau(1-\gamma)}\right]$. Hence, if we subtract the risk-free rate from both sides of the equation, we have:

$$\left(\hat{k}_m - r_f\right) = \left\{\hat{k}_e\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right] - r_f\right\} + \hat{k}_e\left[\frac{\gamma\tau}{1-\tau(1-\gamma)}\right]$$

.

$$MRP = \begin{matrix}\text{Risk premium from} \\ \text{dividends and capital gains}\end{matrix} + \begin{matrix}\text{Risk premium from} \\ \text{franking credits}\end{matrix}$$

Recall that Officer (1994) has shown that dividends and capital gains make up a proportion:

$$\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right]$$

of the total return to equity, the balance due to the value of franking credits. Next, define MRP_{fr} to be the market risk premium including franking credits and MRP_{dc} to be the market risk premium from dividends and capital gains only. Now, the *total* return on the market portfolio, including franking credits is $MRP_{fr} + r_f$ and the return from dividends and capital gains only is $MRP_{dc} + r_f$.

Hence,

$$\begin{bmatrix}\text{Market return from}\\ \text{dividends and capital}\\ \text{gains.}\end{bmatrix} = \begin{bmatrix}\text{Market return from}\\ \text{dividends, capital gains}\\ \text{and franking credits.}\end{bmatrix}\left[\frac{1-T}{1-T(1-\gamma)}\right].$$

This implies that:

$$MRP_{dc} + r_f = \left[MRP_{fc} + r_f\right]\left[\frac{1-\tau}{1-\tau(1-\gamma)}\right],$$

in which case:

$$MRP_{fr} = \frac{r_f + MRP_{dc}}{(1-\tau)/[1-\tau(1-\gamma)]} - r_f.$$

1.4.4. Interpreting the QCA's MRP estimate

In the Draft Determination, the Authority (2004) adopts the following parameter estimates:

- MRP = 6%;
- $\tau = 30\%$;
- $\gamma = 0.5$; and
- $r_f = 5.41\%$.

It is unclear whether the estimate of MRP is assumed to include the assumed value of franking credits. Presumably it does not, given that the Draft Determination is silent on this point and the data sources used to justify that estimate are based on dividends and capital gains only. The next section shows that where other Australian regulators have given consideration to adding the value of franking credits to the estimate of MRP, such adjustments are generally inadequate or inconsistent with other empirical data. To further illustrate this, consider the market portfolio which has an equity beta of 1.0. If gamma is assumed to be 0.5 and if a 6% estimate of the MRP is assumed to include the value of franking credits, the total return required by equityholders would be 11.41%. In particular, this required return would

consist of around 9.4% from cash dividends and capital gains (82% of the total return), and 2.0% from the value of franking credits (18% of the total return).

The return of 9.4% consisting of cash dividends and capital gains is a premium of just 4.0% above the risk-free rate of interest. In other words, in the absence of dividend imputation, the average stock on the Australian equity market would be expected to earn a return from dividends and capital gains just 4.0% above the risk-free rate. This is unreasonable, considering the historical evidence. For example:

- Dimson, Marsh and Staunton (2003) report that the average arithmetic mean of Australian equity returns (measured as dividends plus capital gains only) relative to Government bonds was 7.6% from 1900-2002 with a standard deviation of 19.0%, which is significantly different from 4.0% at a level of just 2%, and
- Out of the 16 developed markets studied, they report that only two had a market risk premium of less than 4.0% (based on dividends and capital gains).

Moreover, this interpretation is also demonstrably inconsistent with observed dividend yields. If the MRP estimate of 6% is assumed to include the value of franking credits, the total return required on the market portfolio is 11.4% $\left(r_f + MRP = 5.4\% + 6\%\right)$. We have shown that application of the results in Officer (1994) implies that if $\gamma = 0.5$ equity investors receive a return of 2.0% from franking credits and 9.4% from dividends and capital gains. If we further assume that franking credits once distributed are valued at around 60% of face value[9], the yield of franking credits must be 3.4% $\left(\frac{2.0\%}{0.6}\right)$. That is, the average firm in the market portfolio must distribute franking credits with face value of 3.4% of the stock price. At a corporate tax rate of 30%, with every $1 of dividends paid, franking credits of 43 cents $\left(\frac{\tau}{1-\tau} = \frac{0.3}{1-0.3}\right)$ can be distributed. Therefore, to generate a franking credit yield of 3.4%, the average firm must generate a dividend

[9] This "utilization rate" is consistent with the economy-wide utilization of franking credits reported by Hathaway and Officer (2002). It has also been used by ESCOSA (2000, footnote 135) in the Draft 2005 - 2010 Electricity Distribution Price Determination. The QCA estimate this parameter to three decimal places and routinely use an estimate of 62.5%, including in the Draft Determination.

yield of 7.8% $\left(\frac{3.4\%}{0.43}\right)$. That is, a $100 stock pays a dividend of $7.80, with franking credits of $3.40, if fully franked. This franking credit is then worth $2.00 to the relevant investor. To the extent that not all dividends are fully franked, the aggregate dividend yield on the market portfolio would have to be even higher than 7.8%. Since the observed dividend yield on the market portfolio is an order of magnitude less than this, the assumptions of $\gamma = 0.5$ and MRP = 6% are dramatically inconsistent with observed market data.

For all of these reasons, we conclude that **the empirical evidence supports an estimate of MRP in a range centered at 6%, excluding any value from franking credits.** To the extent that franking credits are assumed to have value, this value must be added to the estimate of around 6%, which is consistent with evidence from dividends and capital gains only. Using the parameter estimates of $\gamma = 0.5$, MRP = 6% the required adjustment is:

$$MRP_{fr} = \frac{r_f + MRP_{dc}}{(1-\tau)/[1-\tau(1-\gamma)]} - r_f$$
$$= \frac{5.41 + 6\%}{(1-0.3)/[1-0.3(1-0.5)]} - 5.41\% = 8.4\%.$$

That is, if the MRP from dividends and capital gains is only 6% and $\gamma = 0.5$ and other parameters take the values assumed in the Draft Determination, the MRP including the value of franking credits must be 8.4% to preserve the internal consistency of the Officer (1994) framework.

Of course, the other way of restoring internal consistency is to leave the MRP unadjusted and set $\gamma = 0$, consistent with the most recent empirical evidence on this point.

1.4.5. Australian regulatory adjustments for franking credits

We noted above that some Australian regulators had recognized the link between MRP and gamma at a conceptual level, but that this had not led any to make any tangible adjustment to the standard regulatory assumptions of γ = 0.5 and MRP = 6%. This is likely due to the fact that the magnitude of the effect has been under-estimated. To the extent that attempts have been made to quantify the relationship

between MRP and gamma, Australian regulators have relied on additional market data such as dividend yields and utilization rates. As we have illustrated, however, the Officer (1994) framework provides a mathematically deterministic relationship between MRP and gamma, that depends only on the assumed WACC parameters. In this section, we show that the approach based on dividend yield data suggests a much smaller effect than the approach based on the mathematical relationship that must exist. This does not imply that either approach is wrong. It simply means that the assumed WACC parameters are inconsistent with the empirical data on dividend yields. In the remainder of this section, we illustrate this issue via several Australian regulatory examples.

In the Review of Gas Access Arrangements Final Decision (2002, p. 324), the Essential Services Commission implicitly notes that there are three components to the equity return: dividends, capital gains and franking credits. The standard way in which equity returns are measured is in terms of dividends and capital gains only. Thus, the value of franking credits must be added to any such measure (to the extent that franking credits have any value to the relevant investor). The Commission reports that (p. 324), "its assumption about the value of franking credits requires an upward adjustment to the measured cash equity premium to add back the non-cash value of franking credits since 1987 - which the Commission has estimated to add 0.2 percentage points onto the long term average." Further calculations indicate that this adjustment was applied by adding around 0.86% to each observation post 1987, thus increasing the average observed MRP from 1950 by 0.2%. Since this affects 14 of 55 observations, each of those 14 observations must be higher by around 0.86% to cause the average over 55 observations to rise by 0.2%. That is, the Commission values franking credits as providing a return of around 0.86% p.a. for the average stock (equity beta of 1).

In the Draft 2005 - 2010 Electricity Distribution Price Determination ESCOSA (2000, p. 179) notes that the "non-cash value of franking credits for the period since 1987" must be included when estimating the MRP. A similar adjustment, of around 0.86% p.a., is used.

If, however, $\gamma = 0.5$, this adjustment is demonstrably inconsistent with observed market data. To see this, note that if the value of franking credits is 0.86% and if $\gamma = 0.5$, then the total amount of franking credits created (expressed as a percentage

of equity value) must be $\frac{0.86\%}{0.5} = 1.72\%$. Since franking credits are created by the payment of Australian corporate tax, this also represents the amount of tax paid. Thus, the average company return before corporate tax must be 5.73% $\left(\frac{1.72\%}{0.3}\right)$, generating tax of 1.72% and an after company tax of return of only 4.01%. These values are all expressed as a percentage of the equity value. If expressed as a percentage of total firm value, they are even lower! Clearly these implied returns are economically unreasonable.

Internal consistency demands that either a lower value of gamma or a higher adjustment for the value of franking credits must be employed.

The Essential Services Commission has also sought to adjust its "ex-ante" estimates of MRP to account for the assumed value of franking credits. In the Electricity Distribution Price Review Draft Decision (2000, p. 156-8), the Commission notes that a "grossed-up" dividend yield, that includes the assumed value of franking credits, must be used. This implies that the return to equity-holders is:

$$r_e = \frac{D_o}{P_o}\left[\frac{1-T(1-\gamma)}{1-T}\right] + g$$

where $\frac{D_o}{P_o}$ is the current dividend yield and g is the perpetual growth rate of dividends (and earnings if the payout ratio is assumed to be constant). As well as applying to individual stocks, this relationship also applies to the market in aggregate. In this case, the dividend yield and growth rate are interpreted as market wide estimates.

Using estimate of $\gamma = 0.5$ and T = 30%, and a dividend yield of 4% (consistent with recent data), the expected return on the market portfolio is:

$$\begin{aligned} r_m &= 4\%(1.21) + g \\ &= 4.86\% + g. \end{aligned}$$

Subtracting the risk-free rate from both sides yields:

$$MRP = r_m - r_f = 4.86\% + g - r_f .$$

The Commission then assumes that the growth rate is equal to the risk-free rate, giving a MRP estimate of 4.86%. At a risk-free rate of 5.72%, the expected return on the average stock is 10.6%. This 10.6% expected return is made up of three components, as follows:

- Dividends 4% p.a.;
- Franking credits 0.86% p.a.; and
- Capital gains 5.72% p.a.

Once again, the adjustment for the value of franking credits is demonstrably inconsistent with observed market data. If $\gamma = 0.5$ and T = 30%, and if franking credits have a value to investors of only 0.86% the average firm must return only 4.01% after company tax which equates to 5.73% before company tax. Consider a $100 stock. The company generates pre-tax earnings of $5.73, pays tax of $0.3 \times 5.73 = \$1.72$ and creates franking credits worth $1.72. It then pays a dividend of $4.00 and attaches the $1.72 franking credit. (Note that $4.00 \frac{0.3}{1-0.3} = 1.72$.) This credit is then worth 0.86 to the recipient. Since the value of the credit equals half the amount of credits created this is consistent with $\gamma = 0.5$. Clearly, such a low return is economically unreasonable. It is also inconsistent with the ex-ante model, because there are no residual earnings to be reinvested to generate future growth. Thus there is no scope for any capital gain component of returns, so g = 0. However, we cannot consider a higher return, because then more tax would be paid and more franking credits would be created and this would be inconsistent with the assumption that $\gamma = 0.5$. Noting that not all franking credits are immediately distributed does not help either. This is because gamma is the ratio of the value of franking credits to the amount of credits *created* not *distributed*. If the distribution rate is assumed to be lower, the "utilization" rate would have to be compensatingly higher to ensure that γ remains equal to 0.5.

That is, dividend yield data should not be used as the basis for adjusting the MRP estimate. Rather, it should be used to check the reasonableness and internal consistency of the WACC parameter values that have been assumed

or estimated. The combination of parameters that has been assumed is simply impossible to sustain, given an observed dividend yield of around 4%.

1.4.6. The way forward

The Authority's past determinations do not deal formally with the inter-relationship between the estimate of gamma and the estimate of MRP (particularly the mathematically deterministic relationship between them), as this has not been raised in any past submission.

Thus, the Authority now has an opportunity to provide regulatory leadership on this issue – to redress the inconsistency in the Australian regulatory framework between the estimates of γ and MRP. There are two ways in which this can be done.

Adjusting Gamma to restore internal consistency

Setting gamma equal to zero is consistent with the latest empirical evidence. This also implies that the MRP of 6% is due entirely to dividends and capital gains. This is also consistent with the available empirical evidence.

Adjusting MRP to restore internal consistency

Internal consistency requires that the market risk premium be adjusted for the assumed value of franking credits as:

$$MRP_{fr} = \frac{\left(r_f + MRP_{dc}\right)}{\left(1-\tau\right)/\left[1-\tau\left(1-\gamma\right)\right]} - r_f$$

where MRP_{fr} = market risk premium including franking benefits; and MRP_{dc} = market risk premium from dividends and capital gains.

This relationship must hold to preserve the internal consistency of the Officer (1994) framework.

Which of these options should be pursued could be determined with reference to other data, such as observed dividend yields. Our focus here is on the *internal* consistency between the parameters that have been used to compute the WACC.

It is inconsistent to assume that franking credits are valuable such that they reduce corporate cost of equity, but then ignore them when estimating the market risk premium.

1.4.7. Officer (1994) revisited

In the paper that essentially develops the Australian regulatory framework, Officer (1994) specifically addresses this issue. He states (p. 10) that "if the imputation tax does not affect the cost of capital…then we could estimate [expected returns] using historical rates estimated under a classical tax regime." That is, if gamma is zero, we can estimate MRP as usual and continue to use 6%. If however, franking credits are valuable, the standard estimate of MRP must be adjusted to reflect the value of franking credits. It is this adjustment that is described in this paper.

2. Gamma and Foreign Investors

2.1. Overview

In the Draft Determination, the Authority notes that the value of franking credits, gamma, depends on the rate at which franking credits are distributed and the rate at which they are valued, once distributed. We agree with the Authority's assessment of the components of the value of franking credits.

Of course, it is well recognized that franking credits are likely to be valued differently by different investors. It is impossible to observe the value that any investor, or group of investors, places on franking credits. Thus, there are two ways to proceed when assigning a value to the parameter gamma:

1. Assume the identity of the relevant investor type and assume the value that type of investor places on franking credits once distributed; or
2. Make no assumption about the relevant investor type and try to infer the value of franking credits from market data.

That is, a value for gamma can either be assumed, or estimated with reference to market data.

The first approach essentially involves assuming away the existence of foreign investors. In the Draft Determination, the Authority endorses this approach at a conceptual level, stating (p.105) that "introducing the concept of a foreign investor is inconsistent with a domestic CAPM model," and that there is, "a strong case that the value of the utilization rate in the context of the Officer CAPM should be one, for consistency with the domestic framework of the model." Moreover, in the consultant's report, Lally (2004, p. 35) rejects the use of any empirical estimate "that is potentially significantly influenced by the presence of foreign investors" as this "introduces an inconsistency into the model."

Nevertheless, the Authority does not implement this approach, instead relying on its previously-held estimates based on aggregate tax statistics.

In this section, we examine the advantages and disadvantages of each approach.

2.2. Should Australian capital markets be assumed to be integrated with, or completely segmented from, global capital markets?

This question arises in relation to the well-known views of the Authority's consultant on these matters. In the consultant's report, Lally (2004, p. 35) rejects the use of any empirical estimate "that is potentially significantly influenced by the presence of foreign investors" as this "introduces an inconsistency into the model." He summarises (p. 42) that the empirical evidence reflects "the presence of foreign investors. By contrast, the use of a domestic CAPM such as the Officer model implies that national share markets are segregated…consequently an estimate for the utilization rate of close to one is appropriate." That is, the available market evidence should be ignored and replaced with an assumed value to preserve theoretical consistency. The value of franking credits should be assumed rather than estimated. This implies that we should not estimate γ as it is, but as it would be if Australia were perfectly segmented from world capital markets.

Clearly, there is overwhelming and obvious evidence of Australia's integration into global capital markets. Constraints on cross-border capital flows are minimal. Importantly, 30-40% of Australian equities are owned by non-residents.

In spite of this evidence, it is proposed that we should *assume* that Australian capital markets are perfectly segmented from the rest of the world. Lally (2004) argues that perfect segmentation should be assumed in order to preserve consistency with the domestic version of the CAPM that is employed by Australian regulators. That is, the model assumes segmentation, so we must measure all parameters in a way that is consistent with this assumption. This requires us to reject the available empirical evidence on the value of franking credits as this evidence is contaminated by foreigners. We should, instead, estimate γ as it would be if Australia were perfectly segmented.

However, if this were done, we must also estimate the risk-free rate, market risk premium, and beta not as they are, but as they would be in the absence of foreign investment. For example, the risk-free rate would likely be significantly higher if the supply of debt capital were reduced by removing all foreign investment. Clearly, re-estimating all WACC parameters as they would be in the absence of foreign investment is an impossible task and this approach must be rejected.

That is, all WACC parameters should be estimated as they *are*, not as they *would be* if a particular theoretical assumption were to hold.

This leads Lally (2002, 2004) to suggest that the alternative to a theoretically pure domestic CAPM is a version of the international CAPM. He suggests that (p.35) WACC estimates would fall under an international CAPM as "the adverse effect upon the usability of imputation credits is likely to be more than offset by the positive effects from a lower CAPM premium." No empirical analysis of this claim is offered; therefore we examine the most recent and comprehensive evidence on this issue below.

2.3. Consistency with Asset Pricing Models

In Australia, commercial and regulatory practice is to use the standard domestic CAPM to estimate a firm's cost of equity capital. This standard CAPM is implemented by using parameter estimates based on domestic Australian data. The risk-free rate is estimated as the yield on Australian government bonds. The market risk premium is estimated by observing historical Australian stock and bond returns. The equity beta is interpreted as a measure of the relationship between the returns on the firm's equity with the returns on a broad index of Australian stocks.

The mathematical derivation of the CAPM assumes that all investors can borrow and lend as much as they like at the risk-free rate and that all investors hold the risk-free asset and the market portfolio of risky assets, in some proportion.

The theoretical implications of the CAPM and the standard implementation of that asset pricing model can only be reconciled by considering the Australian domestic economy to be *the* market. This is because (i) the CAPM implies that *all* investors face the same risk-free rate and the same market portfolio; and (ii) the standard implementation of the CAPM is based on a domestic Australian risk-free rate and a domestic Australian market portfolio.

This implies that theoretical consistency between (i) the standard CAPM (which is used as the asset pricing model that forms the basis for the calculation of the cost of equity capital) and (ii) the way the CAPM is implemented in practice and by regulators, requires the additional assumption that Australia is perfectly segregated from the world economy. That is, Australia must be considered to be *the* market and

all investors in the CAPM must be assumed to be domestic Australian investors. All forms of foreign investment and cross-border capital flow must be explicitly ignored. Even though there is clear and obvious evidence of significant foreign investment in Australia, this must be ignored if theoretical consistency with the domestic CAPM is to be preserved.

We have noted that this has led the Authority's consultant to suggest that theoretical consistency with the standard CAPM requires that we rule out any effect that non-resident investors may have on the value of franking credits. That is, even though we know that significant amounts of franking credits are paid to non-residents who cannot redeem them, some would suggest that we ignore this because non-resident investors cannot theoretically exist within the standard CAPM as it is commonly implemented.

The particular view advocated by this consultant is well-known. For example, Lally (2002) concludes (pp. 3-4) that, "use of a version of the Capital Asset Pricing Model that assumes that national equity markets are segmented rather than integrated is recommended. It follows that foreign investors must be completely disregarded. Consistent with the disregarding of foreign investors, most investors recognized by the model would then be able to fully utilize imputation credits".

It should be noted that the Ralph reforms occurred subsequent to the writing of this paper. Now, even tax-exempt domestic investors benefit (via a rebate) from receiving franking credits. Presumably not "most", but "all" investors recognized by the model would fully value franking credits now.

Lally (2002) continues (p. 4) to note that, "the product of the utilization rate and the ratio of imputation credits assigned to company tax paid (denoted gamma by the ACCC) should be at or close to 1 for most companies rather than the currently employed figure of 0.50. The effect of this change would be to reduce the allowed output prices of regulated firms."

This conclusion follows from the fact that all non-resident investment is ignored. That is, gamma should be set close to one based on a theoretical assumption, despite clear empirical evidence to the contrary. This is made subsequently clearer (p. 34), "the principal holders of Australian equities are foreigners, companies, superannuation funds and individuals…on account of assuming that national capital

markets are segregated, recognition of foreign investors is both inconsistent and leads to perverse results. Accordingly they are omitted from consideration."

That is, there is clear contrast between the empirical reality of non-resident investment and the theoretical assumption in which they are "omitted from consideration."

There are at least two reasons to reject the argument that preserving the theoretical consistency of an imperfect model should be preferred to recognizing the empirical evidence of non-resident investment. That is, there are two reasons why we should try to estimate gamma as it *is*, rather than as it *would be* if non-resident investment did not exist.

Reason #1: The standard CAPM has many other theoretical problems, but is still the industry standard in practice.

Many of the CAPM's assumptions are not supported in practice. It is clear that not all investors can borrow and lend unlimited amounts at the risk-free rate. Should we omit from consideration all investors who cannot borrow and lend at the same rate as the government? It is clear that not all investors hold the market portfolio. Should we omit from consideration all investors who own anything but index funds? The CAPM is a one-period model. Should we omit from consideration all investors who consider reinvestment risk?

If investors who violate these assumptions remain in consideration, why not continue to consider non-resident investors?

Moreover, if non-residents are to be omitted from consideration in regard to franking credits, they should also be omitted from consideration in regard to other WACC parameters. This requires that the asset beta, risk-free rate, and market risk premium be recomputed to reflect the values they would take in the absence of foreign investment. It is likely that the supply of foreign capital has reduced the risk-free rate and market risk premium, but any quantification of this effect is clearly difficult. In any event, as explained below, this is probably unnecessary.

The key point here is that the CAPM, and all asset-pricing models, are merely tools to help approximate very complex equilibrium outcomes. No such model will be perfect. The standard CAPM is the most widely used asset pricing model in

commercial practice. Graham and Harvey (2001), for example, report that three quarters of U.S. Fortune 500 CFO's always, or almost always, use the standard CAPM to compute cost of equity capital. Why does this model have such widespread acceptance in practice? Not because of the reality of its assumptions, but because it is implementable and it serves the purpose. Moreover, it is clear that when implementing the CAPM, parameters are estimated as they are, not as they would be if all investors who violated any theoretical assumption did not exist.

Reason #2: The domestic CAPM serves as a close approximation of an international CAPM anyway.

Lally (2002, 2004) notes that if non-resident investors are to be considered, it is theoretically inconsistent to use the standard domestic CAPM. He argues that theoretical consistency requires the use of an international version of the CAPM. He conjectures that within such an international CAPM, beta estimates and the market risk premium may be lower than in the domestic CAPM. He rejects the use of such an international CAPM on the basis of (i) the additional complexity of the model and parameter estimates required, (ii) the problem of choosing one specification among a long list of proposed international CAPM's; and (iii) lack of evidence of performance superior to the domestic CAPM.

To examine the effect of moving to an international CAPM, Koedijk, Kool, Schotman and van Dijk (2002) and Koedijk and van Dijk (2004) have compared cost of equity estimates from international and domestic CAPM's. In particular, they test whether the cost of equity computed in the standard manner using the domestic CAPM differs from that computed using the international CAPM models.

For their sample of over 100 Australian firms, they conclude that the domestic and international CAPM's produce significantly different estimates of the cost of equity for less than 5% of firms. The rates are comparable for eight other developed markets that were examined.

That is, standard implementation of the domestic CAPM produces estimates of the cost of equity that are not significantly different from estimates produced by a more complex international CAPM. If non-resident investors do exist, theoretical consistency requires the use of an international CAPM. However, this dramatically

increases the complexity, and cost of regulation, and produces results that are not significantly different from the domestic CAPM anyway.

Thus, if the theoretical inconsistency between the existence of non-resident investors and the use of a domestic CAPM is to be weighed against commercial outcomes and practice, the domestic CAPM can simply be considered as a close approximation of the results that would be produced by a more complex international CAPM.

For these reasons, it is recommended that the Authority continue to use the standard domestic CAPM, consistent with industry and regulatory practice, and that all WACC parameters be estimated with reference to market data. The values of WACC parameters should not be assumed, nor adjusted to reflect the value they might take if market participants who violate theoretical modelling assumptions did not exist.

2.4. Hathaway and Officer (2004): Updated analysis

In the Draft Determination (p.104) the Authority notes that "to date the Authority has employed a gamma of 0.50, which comprises a value of 0.625 for the utilization rate and 0.80 for the imputation credits to tax paid ratio."[10] Thus, the estimate of gamma=0.5, which is maintained in the Draft Determination, is based on the aggregate tax statistics data that was analysed by Hathaway and Officer (1998, revised 2000). In that paper, the authors state that "the access factor is 80%" and that "about 60% of distributed credits are being redeemed." This same evidence was used as the basis for the "reasonable assumption" of 0.5 that appears in Schedule 6.1 of the Code.

We have previously submitted that data from aggregate taxation statistics is uninformative about the value of franking credits. Whereas it does illustrate how many franking credits are used, it tells us nothing about their value or the impact on the firm's cost of capital. Similarly, knowing how many individuals hold shares tells us nothing about the market risk premium. Rather, an empirical estimate based on traded prices is required.

These arguments, and empirical methodologies that are based on traded market prices rather than aggregate tax statistics and theoretical assumptions have been

[10] This second component is often called the "distribution rate."

rejected by the Authority on the basis of the theoretical reasoning of its consultant. We believe that the reasons provided for rejecting estimates of gamma that are based on traded prices from financial markets are not well founded. Should the Authority wish to alter its view that gamma can only be assumed or estimated as the product of the economy-wide distribution rate and the economy-wide utilization rate, we would welcome the opportunity to make further submissions.

If, however, the Authority maintains its view that the aggregate tax statistic methodology of Hathaway and Officer (1998, 2000) should be adopted such that other (peer-reviewed and published) methodologies are excluded, we note that Hathaway and Officer (2004) present a revised version of their work. This revision contains updated data and more detailed and careful analysis. Their conclusion is that "the access factor is 71% and about 50% of distributed credits are being redeemed. Overall, about 35% of company tax is actually a pre-payment of personal tax."

That is, the data set, methodology, and authors on which the Authority relies for its estimate of gamma =0.5 now report, on the basis of more recent data, that the appropriate estimate is now gamma = 0.35.

3. Effective vs. Statutory Tax Rates

3.1. Regulated revenue for a firm with tax losses carried forward

The appropriate regulated revenue for a firm not currently paying tax, but expected to pay tax in the future, is the same as that for a firm currently paying tax. This is the situation that applies to a firm not paying tax due to accumulated tax losses, or to a firm paying tax at a rate less than the statutory rate of 30 percent, due to timing differences. The additional cash flows the non-tax-paying firm receives as a result of not paying tax have a present value exactly equal to the present value of its accumulated tax losses, or the present value of the additional cash flows from the timing differences. Hence, the same revenue stream allows both tax-paying and non-tax-paying firms to earn a return commensurate with their risk.

The Authority is concerned that using the statutory tax rate, rather than the effective tax rate, results in a wealth transfer from consumers to the regulated firm. However, by adopting the effective tax rate, the Authority actually produces the opposite result. Tax losses carried forward are an asset of the firm, whose value can only be recouped by a reduction in taxes payable in future periods. By adopting the effective tax rate in setting prices, the value of this asset is reduced to zero. Hence, there is a wealth transfer away from the firm which negates the specific intent of the tax provisions.

3.2. Regulated revenue for a tax-paying firm

Standard finance theory states that the value of a firm is the present value of its expected future cash flows, which implies the following equation:

$$V = \sum_{i=1}^{\infty} \frac{FCFF_i}{(1+WACC)^i}$$

where:

V = value of the firm;

$FCFF_i$ = free cash flow to the firm in year i;

$WACC$ = weighted average cost of capital, equal to $r_d(1-\tau)D/V + r_e\,E/V$;

r_e = the return required by the providers of equity capital;

r_d = the return provided by the providers of debt capital;

τ = the corporate tax rate;
D/V = the proportion of debt in the firm's capital structure; and
E/V = the proportion of equity in the firm's capital structure.

If we assume that the firm is operating in steady state, earning a perpetual stream of cash flows and with capital expenditure just offsetting depreciation, the equation simplifies to:

$$V = \frac{FCFF}{WACC}$$
$$V = \frac{EBIT(1-\tau) + DEPN - CAPEX}{WACC}$$
$$V = \frac{EBIT(1-\tau)}{WACC}$$

where:

$EBIT$ = earnings before interest and tax;
$DEPN$ = depreciation and amortisation; and
$CAPEX$ = capital expenditure.

In the case of a regulated firm, value is typically determined according to a formula for estimating the regulated asset base (RAB). Given the regulated asset base and an estimate of an appropriate cost of capital, the regulated revenue stream is determined as the product of the regulated asset base and the cost of capital, plus an allowance for taxes and efficient operating costs. This regulated revenue stream can be estimated be re-arranging the above formula, assuming that value (V) is now externally estimated as the regulated asset base.

$$EBIT = \frac{RAB \times WACC}{(1-\tau)} \Rightarrow$$
$$REV = \frac{RAB \times WACC}{(1-\tau)} + DEPN + COSTS$$

where:

RAB = regulated asset base;
REV = regulated revenue;

DEPN = depreciation and amortisation; and
COSTS = other operating costs.

3.3. Regulated revenue for a non tax-paying firm

Now consider the case of an unregulated firm that has incurred tax losses in the past, but which is expected to start paying tax in n years. The value of the non-tax-paying firm can be determined according to the following formula:

$$V_{non} = \sum_{i=1}^{n} \frac{FCFF_{non,i}}{(1+WACC)^{i}} + \frac{FCFF_{non,n+1}}{WACC(1+WACC)^{n}}$$

where:

V_{non} = value of the non-tax-paying firm; and
$FCFF_{non,i}$ = free cash flow to the non-tax-paying firm in year *i*.

This simply states that the value of the non-tax-paying firm is the present value of its expected future cash flows, but allows for the possibility that those cash flows could be different in the years before the firm starts to pay tax.

We can measure the value of the non-tax-paying firm in another way. This firm essentially receives additional free cash flow of (*EBIT* x τ) for *n* years. **Therefore, the value of the non-tax-paying firm is equal to the value of the tax-paying firm, plus the present value of the tax savings**. Applying the formula for the present value of an annuity to a cash flow stream of (*EBIT* x τ), we have:

$$V_{non} = V + \frac{EBIT \times \tau}{WACC}\left[1 - \frac{1}{(1+WACC)^{n}}\right]$$

The two expressions for the value of a non-tax-paying firm must lead to equivalent valuations – both are simply the present value of expected future cash flows – so we can combine them into the following equation:

$$V + \frac{EBIT \times \tau}{WACC}\left[1 - \frac{1}{(1+WACC)^{n}}\right] = \sum_{i=1}^{n} \frac{FCFF_{non,i}}{(1+WACC)^{i}} + \frac{FCFF_{non,n+1}}{WACC(1+WACC)^{n}}$$

The last term of this equation contains the factor $\frac{FCFF_{non,n+1}}{WACC}$. Once the firm starts paying tax in year $n + 1$, its free cash flows will be the same as those of a tax-paying firm, implying that $FCFF_{non,n+1} = FCFF$. Hence, the last term contains the factor $\frac{FCFF}{WACC}$, which is equal to V, so we can re-write this equation as:

$$V + \frac{EBIT \times \tau}{WACC}\left[1 - \frac{1}{(1+WACC)^n}\right] = \sum_{i=1}^{n} \frac{FCFF_{non,i}}{(1+WACC)^i} + \frac{V}{(1+WACC)^n}$$

Now consider the case of the regulated firm, where V is now estimated as the regulated asset base (RAB). Our objective is to estimate the appropriate free cash flow to the firm in the years when it pays no tax, so that it earns a return on investment commensurate with its risk. Re-arranging the above equation, we have:

$$\sum_{i=1}^{n} \frac{FCFF_{non,i}}{(1+WACC)^i} = \frac{EBIT}{WACC}\left[1 - \frac{1}{(1+WACC)^n}\right]$$

This equation shows that the present value of the free cash flows to the non-tax-paying firm in the years when it pays no tax is equal to the present value of an annuity, where the annual cash flows equal the $EBIT$ of the tax-paying firm. So, we can solve the equation as:

$$\underset{i=1-n}{FCFF_{non,i}} = EBIT$$

Simply, the non-tax-paying firm receives higher cash flows than the tax-paying firm, but the present value of these additional cash flows is exactly equal to the value of the tax losses carried forward. This does not impact on the appropriate revenue, which can be estimated in the same way for both firms as:

$$REV = \frac{RAB \times WACC}{(1-\tau)} + DEPN + COSTS\,.$$

3.4. Illustration

Consider the case of a tax-paying firm with a regulated asset base of $100 million, depreciation of $4 million per year (equal to its capital expenditure), operating costs

of $20 million per year, a weighted average cost of capital of 7.5%, and a corporate tax rate of 30%. Its regulated revenue should be $34.7 million, determined as follows:

$$\begin{aligned} REV &= \frac{RAB \times WACC}{(1-\tau)} + DEPN + COSTS \\ &= \frac{100 \times 0.075}{1-0.3} + 4 + 20 \\ &= \$34.7\text{m} \end{aligned}$$

This revenue allows the firm to generate *EBIT* of $10.7 million per year, which implies free cash flow to the firm (*FCFF*) of $7.5 million per year. These free cash flows have a present value of $100 million, equal to the regulated asset base.

Now, consider the case of an identical firm that is not expected to pay tax until year six. The revenue should still remain $34.7 million per year, but the free cash flows to the firm will increase in years 1-5 to $10.7 million (*EBIT*). The present value of the free cash flows to the firm are now $113 million, computed as follows:

$$\begin{aligned} V_{non} &= \sum_{i=1}^{n} \frac{FCFF_{non,i}}{(1+WACC)^i} + \frac{FCFF_{non,n+1}}{WACC(1+WACC)^n} \\ &= \frac{EBIT}{WACC}\left[1 - \frac{1}{(1+WACC)^n}\right] + \frac{EBIT(1-\tau)}{WACC(1+WACC)^n} \\ &= \frac{10.7}{0.075}\left[1 - \frac{1}{(1.075)^5}\right] + \frac{10.7 \times (1-0.3)}{0.075 \times (1.075)^5} \\ &= \$113\text{m} \end{aligned}$$

There value of the firm is $13 million higher than the regulated asset base of $100 million. But this difference is exactly equal to the value of the tax losses carried forward. For five years, free cash flows to the firm will increase by $3.2 million per year, which have a present value of $13 million, as shown below:

$$PV \text{ of tax losses carried forward} = \frac{3.2}{0.075}\left[1 - \frac{1}{(1.075)^5}\right] = \$13\text{m}$$

Therefore, both the tax-paying and non-tax-paying firms earn an appropriate return by receiving the same regulated revenue stream.

This can be illustrated in the table below. Columns 2-6 refer to the tax-paying firm and show that the firm earns a return on capital of 7.5% in each year. There is no change in firm value, so the economic profit accruing to the providers of capital is equal to the free cash flow to the firm, $7.5 million each year. The return on capital each year is therefore 7.5%.

Columns 7-13 refer to the non-tax-paying firm. For years 1-5, free cash flow to the firm is $10.7 million, due to its no-tax status. However, firm value declines in each of years 1-5 by $2.2 - $3.0 million, due to the reduction in the value of its tax losses carried forward. Hence, the economic profit to the providers of capital range from $7.7 - $8.5 million in these years. As shown in column 13, economic profit in each year is exactly 7.5% of total firm value in each period, so the providers of capital are still earning an appropriate return on investment.

Realised return on capital for a tax-paying and non-tax-paying firm

Year	Tax-paying firm					Non-tax-paying firm						
	RAB	FCFF	Chg V	EP	ROC	RAB	VTL	Value	FCFF	Chg V	EP	ROC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	100	7.5	0.0	7.5	7.5%	100	13.0	113.0	10.7	-2.2	8.5	7.5%
2	100	7.5	0.0	7.5	7.5%	100	10.8	110.8	10.7	-2.4	8.3	7.5%
3	100	7.5	0.0	7.5	7.5%	100	8.4	108.4	10.7	-2.6	8.1	7.5%
4	100	7.5	0.0	7.5	7.5%	100	5.8	105.8	10.7	-2.8	7.9	7.5%
5	100	7.5	0.0	7.5	7.5%	100	3.0	103.0	10.7	-3.0	7.7	7.5%
6	100	7.5	0.0	7.5	7.5%	100	0.0	100.0	7.5	0.0	7.5	7.5%

RAB = regulated asset base;

FCFF = free cash flow to the firm;

Chg V = change in firm value;

EP = economic profit = FCFF + Chg V;

ROC = return on capital = EP/Value;

VTL = value of tax losses; and

Value = total firm value = RAB + VTL.

4. Beta Adjustment for Operating Leverage and Revenue Cap

The ACG report recommends that the regulated rate of return incorporate an equity beta of 0.90, which was accepted by the Authority in its draft determination. An equity beta of 0.90 is consistent with an asset beta of 0.45 and a debt beta of 0.10, assuming gearing = 60%, the corporate tax rate (τ) = 30% and the value of imputation tax credits (γ) = 0.50. This consistency is illustrated below:

$$\begin{aligned}\beta_e &= \beta_a\left\{1+\frac{D}{E}\left[1-\tau(1-\gamma)\right]\right\}-\beta_d\frac{D}{E}\left[1-\tau(1-\gamma)\right]\\ &= 0.45\left\{1+\frac{60}{40}\left[1-0.3(1-0.5)\right]\right\}-0.1\times\frac{60}{40}\left[1-0.3(1-0.5)\right]\\ &= 1.02375-0.1275\\ &= 0.89625\end{aligned}$$

This recommendation is based on the following conclusions:

- The equity beta of the average Australian electricity distributor is 1.00, assuming 60% gearing;
- Queensland electricity distributors are expected to have higher operating leverage (that is, a higher proportion of fixed costs relative to total costs) which increases systematic risk;
- But this impact is more than offset by a reduction in systematic risk that results from the use of a revenue cap and other Queensland regulatory arrangements.

In relation to the final assumption regarding the impact of Queensland regulatory arrangements, it is not entirely clear that the revenue cap has this directional effect. While it reduces the correlation with market returns, compared to the operation of a price cap, it increases the volatility of firm returns, which occurs when forecast and actual volumes differ. As it is the product of the correlation with market returns and volatility of returns that affects beta, it is not necessarily the case that the Queensland regulatory arrangements reduce the asset beta in this way.

However, the conclusions reached in this section are independent of this point. That is, even if we accept the Authority's assessment of the impact of the revenue cap on systematic risk, the conclusions we reach still hold. So, in the remainder of this

section, we confine our discussion to the impact of operating leverage on the asset beta, by addressing the following questions:

1. What assumptions regarding revenue beta and operating leverage are implicit in the ACG/QCA conclusion that the asset beta is 0.45?
2. Are these assumptions reasonable?
3. Is there a more reasonable set of assumptions that are consistent with an estimated asset beta of 0.5 and is there any evidence to reject these assumptions?

In the original submission, Ergon Energy originally proposed an asset beta drawn from a uniform distribution in the range of 0.4 – 0.6, implying a mid-point estimate of 0.5. Under the Authority's new re-levering approach and their assumptions regarding tax and imputation credits, this would imply a mid-point estimate of the equity beta of 1.0, as shown below:

$$\begin{aligned}\beta_e &= \beta_a\left\{1+\frac{D}{E}\left[1-\tau(1-\gamma)\right]\right\}-\beta_d\frac{D}{E}\left[1-\tau(1-\gamma)\right]\\ &= 0.50\left\{1+\frac{60}{40}\left[1-0.3(1-0.5)\right]\right\}-0.1\times\frac{60}{40}\left[1-0.3(1-0.5)\right]\\ &= 1.1375-0.1275\\ &= 1.01\end{aligned}$$

The issue is whether there is a more reasonable set of assumptions that is consistent with an assumed asset beta of 0.50, rather than the 0.45 assumed by the QCA. Furthermore, the QCA conclusion that an asset beta of 0.45 is appropriate is based on the assumption that the positive impact on systematic risk of higher operating leverage for Queensland distributors is more than offset by the reduction in systematic risk that results from the revenue. We question whether the revenue cap necessarily has this expected impact on systematic risk. But even if we accept that the revenue cap has this effect, we question how it can be established that this impact outweighs the impact of higher operating leverage *without any quantitative analysis of higher operating leverage on the asset beta.*

Specifically, the ACG report states that "whilst the Operating Cost Ratio of the Queensland DSNPs is higher than the Victorian average, the systematic risk impact

of this is mitigated by the fact that [the] QCA has stated that to some extent, cost variances associated with non-controllable events will be adjusted for in a symmetrical fashion through the revenue cap." The only quantitative analysis that is performed in relation to operating leverage is the computation of the relative Operating Cost Ratios of distributors in different states, defined as $\frac{\text{Cash operating costs}}{\text{EBIT} + \text{Cash operating costs}}$. The data shows that Queensland has a higher operating cost ratio, but this computation is not relevant to *operating leverage*, if there is no estimation of the proportion of costs that are fixed. In addition, even if this computation in itself was relevant, the report does not compute *how much* impact the different Operating Cost Ratios should have on the asset beta.

Simply, if it is possible to conclude that the impact of the revenue cap outweighs the impact of higher operating leverage on the asset beta, it must be possible to determine how much impact higher operating leverage would have in the absence of any revenue cap. But this calculation is not performed, and the conclusion that β_a = 0.45, as opposed to β_a = 0.50, is made on the basis of an "on balance" assessment of the impact of operating leverage and the revenue cap. Given the uncertainty surrounding WACC parameter estimates, it is difficult to see how this conclusion can be reached via a qualitative analysis.

The analysis that follows is reasonably technical and relies on placing boundaries on what set of assumptions are firstly, mathematically possible, and secondly, reasonable, given a set of constraints drawn largely from the ACG report and the Draft Determination. At first glance, it may appear unnecessarily technical. But this only occurs because the conclusion has the impact of reducing the regulated rate of return by 0.5% and has been made without stating the underlying assumptions. Hence, the problem is challenging because we have to first derive a set of implicit assumptions before we can assess their reasonableness.

Nevertheless, the analysis implies the following conclusions:

- At an asset beta of 0.45 for the Queensland DNSPs, the maximum ratio of fixed cash costs to total cash costs that is possible is 63%, compared to 52% for the Victorian businesses. In contrast, at an asset beta of 0.50, the ratio of fixed cash costs/total cash costs can range from 65-92%, compared to 50-82% for the Victorian businesses.

- To sustain an asset beta of 0.45 for the Queensland electricity distributor, the reduction in the revenue beta, compared to the Victorian business, is marginal. Given the lack of quantitative analysis of the impact of the revenue cap on systematic risk, we question whether it is reasonable to conclude that the systematic risk of revenue for the Queensland firm is lower than interstate comparables, when the range of possible movement is so slight.

	Qld Elec Dist	Vic Elec Dist	Market
Assumptions consistent with an asset beta = 0.45			
Asset beta	0.45	0.45	0.76
Revenue beta	0.19	0.21	0.36-0.42
Degree of operating leverage	2.4	2.1	1.8-2.1
Fixed cash costs/total cash costs	0.63	0.52	0.10-0.17
Assumptions consistent with an asset beta = 0.50			
Asset beta	0.50	0.45	0.76
Revenue beta	0.19-0.21	0.19-0.21	0.36-0.42
Degree of operating leverage	2.4-2.6	2.1-2.4	1.8-2.3
Fixed cash costs/total cash costs	0.65-0.92	0.50-0.82	0.10-0.21

4.1. The impact of operating leverage on the asset beta

In relation to the impact of operating leverage on systematic risk, the ACG report references two sources that analyse the relationship between operating leverage and systematic risk (Mandelker, Gershon and Rhee, 1984 and Brealey and Myers, 1996). The relationship can be summarised by the following equation:

$$\beta_{asset} = \beta_{revenue} \times \text{Degree of operating leverage}$$

$$\beta_{asset} = \beta_{revenue}\left[1+\frac{PV(\text{fixed costs})}{PV(asset)}\right] = \beta_{revenue}\left[1+\frac{\%\text{ change in EBIT}}{\%\text{ change in revenue}}\right]$$

From the equation above, we derived the following equations, which hold under the assumption that the same discount rate is used to value fixed costs and the assets. A more appropriate discount rate for fixed costs is the cost of debt capital, but we ignore this for the moment. Under the more appropriate assumption, operating leverage, the asset beta and the equity beta, would be higher than we discuss below.

$$\beta_{asset} = \beta_{revenue}\left[1+\frac{\text{fixed costs}}{EBIT}\right] = \beta_{revenue}$$

Given the equations above, and the estimated proportion of fixed and variables costs for Queensland electricity distributors, compared to their interstate counterparts, or for the market as a whole, we can isolate the impact of operating leverage on the asset beta.

4.2. What assumptions regarding revenue beta and operating leverage are consistent with an asset beta of 0.45?

The ACG report concludes that the asset beta of the average firm in the Australian market is 0.76, which is 69 percent greater than the assumed asset beta for Queensland electricity distributors, a difference which must be due to a lower revenue beta and/or lower operating leverage for Queensland electricity distributors, relative to the market. The ACG report also concludes that Queensland electricity distributors actually have higher operating leverage than their interstate counterparts and we can reasonably assume that all electricity distributors have higher operating leverage than the typical firm in the market, given their level of fixed assets and the high proportion of operating costs devoted to maintenance. So, we can progress to narrow down the assumptions the report implicitly makes about the revenue beta and the contribution of operating leverage to the asset beta of (1) the typical electricity distribution business; and (2) an electricity distribution business in Queensland, which ACG has concluded has higher operating leverage than interstate distributors.

The chart below illustrates a set of assumptions that are consistent with an electricity distributor having an asset beta of 0.45. We do not know the assumed revenue beta, or the assumed degree of operating leverage because these were not quantified or made explicit in the report. But there are several pairs of assumptions that are mathematically possible under the following additional assumptions, which are summarised in the equations that follow:

- The degree of operating leverage for the typical listed firm is at least 1.3. We make this assumption because the typical listed firm has depreciation of about 30 percent of EBIT and this cost is almost entirely fixed. We estimated this percentage on a value-weighted basis using the most recent income statement data for 254 ASX firms with positive EBIT.
- The degree of operating leverage for an electricity distributor is at least 1.8. According to data in the draft determination the

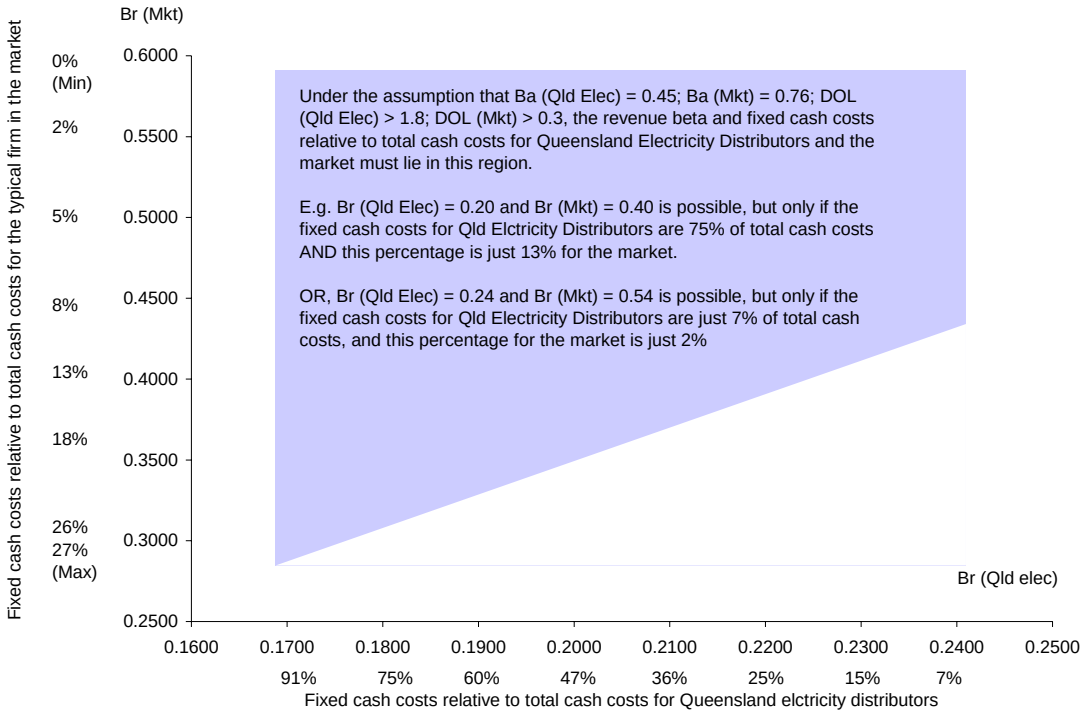
total expected return of capital for Ergon Energy is about 80 percent of the total expected EBIT over the next five-year regulatory period. Using this as an estimate of depreciation, fixed costs relative to EBIT must be at least 80 percent of EBIT.

- The degree of operating leverage for an electricity distributor is greater than the degree of operating leverage for a typical firm. Given that almost 80 percent of the cash operating costs of Ergon Energy are classified as maintenance, it is highly unlikely that the fixed costs of Ergon Energy could be less than the typical firm in the market.

Equations used to derive the assumptions consistent with asset betas of 0.45 for an electricity distributor and 0.76 for the market as used in the QCA draft determination

	Qld Elec Dist	Market
$\beta_r = \frac{\beta_a}{DOL}$	$\beta_r = \frac{0.45}{DOL_Q}$; $DOL_Q > 1.80$	$\beta_r = \frac{0.76}{DOL_M}$; $DOL_M > 1.30$
	$DOL_Q > DOL_M$	
$\frac{Fixed\ cash\ costs}{Total\ cash\ costs} = \frac{DOL - 1 - Depn/EBIT}{Cash\ costs/EBIT}$	$\frac{FCC}{TCC} = \frac{DOL - 1 - 0.80}{0.90}$	$\frac{FCC}{TCC} = \frac{DOL - 1 - 0.30}{4.80}$

Assumptions regarding the revenue beta and ratio of fixed cash costs to total cash costs for an electricity distributor and the market, consistent with the ACG/QCA assumptions



The chart presents the set of assumptions regarding the revenue betas and the ratio of fixed cash costs to total cash costs for an electricity distributor and the market that are consistent with the assumptions that are implicit in the Draft Determination. For example, one set of consistent assumptions is to assume a revenue beta of 0.20 for the distributor and 0.40 for the market, a point which lies in the shaded region. But this is only possible under the further assumptions that DOL_Q = 2.25 and DOL_M = 1.90. After removing depreciation, this requires that 50 percent of the remaining costs for the distributor are fixed, but this percentage is just 12.5 percent for the typical firm in the market.

Alternatively, we could assume that the revenue betas for the distributor and the market are 0.24 and 0.54, respectively. But this implicitly assumes that DOL_Q = 1.9 and DOL_M = 1.4, which in turn implies that fixed cash costs relative to total cash costs are just 8 percent for the distributor and 2 percent for the market.

It is important to note that this set of assumptions regarding the revenue beta and operating leverage is the entire set that satisfies the equations given in the table

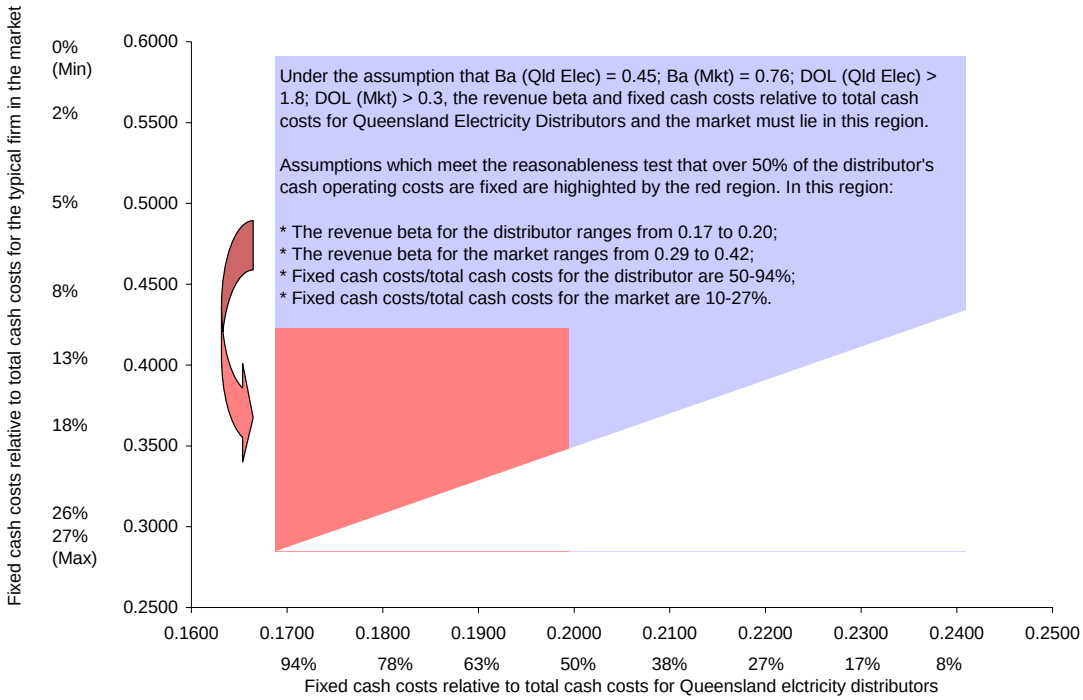
above. So, while sampling error means that there is uncertainty over whether, say, Depreciation/EBIT for the market is actually 0.3 or some other number, we can say that, "given the assumptions that (1) βa (Elec Dist) = 0.45 and βa (Mkt) = 0.76; (2) DEPN/EBIT (Elec Dist) = 0.8 and DEPN/EBIT (Mkt) = 0.3; and (3) Cash costs/EBIT (Elec Dist) = 0.9 and Cash costs/EBIT (Mkt) = 4.8; these are the only potential combinations of revenue beta and ratio of fixed cash costs/total cash costs that are possible."

4.3. Are these assumptions reasonable? Is there a more reasonable set of assumptions that are consistent with an asset beta of 0.50?

Now consider the reasonableness of this set of assumptions. Almost 80 percent of Ergon Energy's cash operating costs are classified as maintenance, so it is reasonable to assume that *at least* 50 percent of its cash operating costs are fixed. We could also reasonably assume that *at least* 10 percent of cash operating costs for the market are fixed. Given these additional assumptions, we can construct the sub-set of assumptions regarding revenue betas and fixed cash costs/total cash costs that remain consistent with asset betas of 0.45 for the distributor and 0.76 for the market. This sub-set is illustrated in the red section of the chart below, which implies that:

- The revenue beta for the distributor lies between 0.17 and 0.21, while the revenue beta for the market lies between 0.29 and 0.42. The revenue beta for the distributor is between 40-58% of the revenue beta for the market.
- The ratio of fixed cash costs/total cash costs for the distributor lies between 50-94%, while this ratio for the market lies between 10-27%. The distributor has 2.7-9.0 times more fixed cash operating costs, per dollar of variable operating costs, relative to the market.

Assumptions regarding the revenue beta and ratio of fixed cash costs to total cash costs for a Queensland electricity distributor and the market, consistent with the ACG/QCA assumptions



Now we can evaluate whether this set of assumptions is reasonable by comparison to Victorian businesses, which ACG suggests should have the lowest operating leverage of any state. We have already established that the implicitly-assumed revenue beta for a Queensland electricity distributor lies between 0.17 and 0.21. And ACG/QCA has concluded that the revenue beta for a Queensland electricity distributor is *lower than* the revenue beta for the typical electricity distributor.

Consider the set of the five electricity distribution businesses in Victoria (AGL, CitiPower, Powercor, TXU and United Energy). Aggregate data for these businesses presented in the *Electricity Distribution Price Determination 2001-2005*, suggests that depreciation and cash operating expenditure are roughly equal and that depreciation relative to EBIT is roughly 75 percent. Under these assumptions, the minimum degree of operating leverage for Victorian electricity distributors is 1.75. And if the typical Victorian business has a revenue beta that is *at least* equal to the revenue beta for a Queensland distribution business, then there is a very narrow set of assumptions that satisfy the conclusion that the asset beta is 0.45. In contrast, there is a slightly wider set of assumptions that satisfy the conclusion that the asset beta is 0.50.

Both of these sets of assumptions are presented in the table below.

	Qld Elec Dist	Vic Elec Dist	Market
Assumptions consistent with an asset beta = 0.45			
Asset beta	0.45	0.45	0.76
Revenue beta	0.19	0.21	0.36-0.42
Degree of operating leverage	2.4	2.1	1.8-2.1
Fixed cash costs/total cash costs	0.63	0.52	0.10-0.17
Assumptions consistent with an asset beta = 0.50			
Asset beta	0.50	0.45	0.76
Revenue beta	0.19-0.21	0.19-0.21	0.36-0.42
Degree of operating leverage	2.4-2.6	2.1-2.4	1.8-2.3
Fixed cash costs/total cash costs	0.65-0.92	0.50-0.82	0.10-0.21

The conclusions from this table are that:

- At an asset beta of 0.45 for the Queensland electricity distributor, the maximum ratio of fixed cash costs to total cash costs that is possible is 63%, compared to 52% for the Victorian businesses. In contrast, at an asset beta of 0.50, the ratio of fixed cash costs/total cash costs can range from 65-92%, compared to 50-82% for the Victorian businesses.
- To sustain an asset beta of 0.45 for the Queensland electricity distributor, the reduction in the revenue beta, compared to the Victorian business, is marginal. Given the lack of quantitative analysis of the impact of the revenue cap on systematic risk, we question whether it is reasonable to conclude that the systematic risk of revenue for the Queensland firm is lower than interstate comparables, when the range of possible movement is so slight.

5. Beta Interpretation

The ACG report makes reaches a misleading conclusion in regard to the equity beta that is consistent with Ergon Energy's proposed regulated rate of return of 9.9%. It states that, "with 60% gearing and the application of the other SFG 'midpoint' estimates, the implied SFG equity beta would need to be 1.41 to derive a WACC of 9.9%." The following section shows that this conclusion is misleading.

The original Ergon Energy submission proposed that the following parameters be used to estimate the regulated rate of return, with the conclusion that an appropriate value is 9.9%. The submission reached this conclusion by following a two-step approach. First, we estimated the distribution of the WACC of an electricity distribution business, stating that the mean estimate was 9.0% and the 75th percentile was 9.6%. Second, the submission proposed that the regulated rate of return be set at 9.9%, as this value implied that there was a 25% chance that a distribution business would not earn its cost of funds.[11]

The table below shows the parameter distributions used to estimate the distribution of the WACC.

[11] In reaching this conclusion, the submission assumed that the realised return was normally distributed with a coefficient of variation = 10%. The coefficient of variation is the standard deviation divided by the mean. So, the assumption that the coefficient of variation = 10% implies that, if the regulated rate of return is, say 9.0%, the realised return will be normally distributed with a mean of 9.0% and a standard deviation of 0.9%. If the regulated return is 9.9%, the realised return will be normally distributed with a mean of 9.9% and a standard deviation of 1.0%.

Parameter	Symbol	Source	Estimate
Risk-free rate of interest	r_f	Yield on 10-year Government bond (20-day average)	5.8%
Capital structure	D/V	Comparables and regulatory decisions	50-60%
Credit rating	—	Comparables and regulatory decisions	BBB
Debt premium	—	BBB Corporate bond yields	1.1-1.3%
Default premium	—	Elton, Gruber, Arawak and Mann (2001)	0.3 -0.5%
Asset Beta	β_a	Comparables and regulatory decisions	0.4-0.6
Market risk premium	MRP	Historical stock returns and 10-year govt. bond yields.	N (6, 1.8)[12]
Corporate tax rate	τ	Statutory rate	30%
Value of franking credits	γ	Published empirical evidence	0

ACG states that they were unable to re-produce an equity beta consistent with our WACC estimate, and compute equity betas of 0.76 using 55% gearing and 0.82 using 60% gearing. This discrepancy arises because the calculations presented in the submission relied on the Authority's previous re-levering method and not our proposed re-levering method, as this method had not yet been adopted by the Authority. That is, using mid-point estimates from the table above, we compute the equity beta as:

$$\beta_e = \beta_a\left(1+\frac{D}{E}\right)-\beta_d\frac{D}{E} = 0.5\left(1+\frac{55}{45}\right)-0.13\left(\frac{55}{45}\right) = 0.95$$

where

$$\beta_d = \frac{Yield - DRP - r_f}{MRP} = \frac{0.070-0.004-0.058}{0.060} = 0.13$$

This implies that the mid-point cost of equity capital (r_e) is 11.49% and the WACC is 9.02%, computed as follows:

$$r_e = r_f + \beta_e \times MRP = 0.058 + 0.95 \times 0.06 = 11.49\%$$

[12] Normal distribution with mean 6% and standard deviation 1.8%, consistent with historical variation in observed market risk premia.

$$WACC = r_e \times \frac{E}{D+E} + yield \times \frac{D}{D+E} = 0.1149 \times 0.45 + 0.07 \times 0.55 = 9.02\%$$

Thus, using mid-point values results in a WACC estimate of 9.0%, the same as the mean value from the simulated distribution, and the implied equity beta from the Authority's previous re-levering approach is 0.95.

ACG goes on to state that our WACC estimate of 9.9% is consistent with an equity beta of 1.41 (at 60% gearing). This is presumably the result of the following calculation:

$$\beta_e = \frac{WACC \times \frac{D+E}{E} - yield \times \frac{D}{E} - r_f}{MRP} = \frac{\frac{0.099}{0.400} - 0.07 \times \frac{60}{40} - 0.058}{0.06} = 1.41$$

This analysis is grossly misleading. The whole point of the simulation analysis is to incorporate the uncertainty of parameter estimates and the interactions between parameters. Taking a particular WACC estimate, fixing values for some parameters, and then deriving the value of another misses the point altogether. Suppose we know that the Australian cricket team scored a total of 600 (analogous to the WACC) and that the first ten batsmen have average scores that total 380 when summed together (analogous to the other parameters). This does not imply that the eleventh batsman must have scored 220 (analogous to the equity beta). A score of 600 is reached by several batsmen scoring above their averages. In the same way, a conservative WACC is reached by taking several parameters above the mid-point, not holding all the others fixed and allowing only one to vary. In none of our 10,000 simulations did the equity beta reach 1.4.[13]

The implication of the ACG analysis is that the proposed regulated rate of return relies on an equity beta estimate that is unreasonably high. This is not the case. The WACC distribution that is presented is the result of varying a number of parameters *simultaneously*, and there was not one of our 10,000 simulated cases in which the equity beta reached the value derived by ACG. The simulated values for the equity beta were, in fact, predominantly in the range of 0.8 to 1.2, with a mean of around one.

[13] Comparable to the odds of Glenn McGrath scoring a double century!

In sum, the conclusion that an equity beta of 1.41 would be required in order to achieve a regulated return of 9.9% (at 60% gearing) is misleading because:

- It assumes that all other parameters are fixed at their mid-points, which is inconsistent with the assumptions of the simulated WACC;
- It ignores the fact that the proposed return of 9.9% is not the 75th percentile of the WACC distribution, but rather the regulated return that is consistent with a 75 percent chance the entity will earn its true cost of funds; and
- The equity beta consistent with the simulated WACC distribution lies predominantly in the range of 0.8 to 1.2, and in none of the 10,000 cases did the equity beta reach the value stated by ACG.

6. Uncertainty and Monte Carlo Simulation

In their original submissions, ENERGEX and Ergon Energy proposed the use of Monte Carlo simulation in order to estimate the distribution of the weighted average cost of capital (WACC) for Queensland electricity distributors. This was proposed in order to estimate the distribution of their true cost of funds, given that the WACC used in regulatory determinations is an *estimate* of the cost of funds, drawn from an underlying distribution. They also relied on statements by the Productivity Commission that recognise that there is some probability that a regulated entity will not earn its regulated return, as operating and capital costs may be different than forecast.

The objective of this exercise was to address two questions:

1. What is a reasonable range for the estimated cost of funds for Queensland electricity distributors?
2. Given a regulated return, what is the probability that a Queensland electricity distributor will earn its true cost of funds?

It is important to address these questions because there may be asymmetric consequences of a regulated entity earning more or less than its true cost of funds. Specifically, if there is too great a probability that the entity will earn less than its cost of funds, there will be reduced investment in infrastructure, which will result in a loss of business productivity and poor service to customers.

The Authority rejected this approach on advice from ACG. We have concerns over the reasons the Authority cites for rejecting the Monte Carlo simulation technique as well as the ACG report itself. Consider the reasons cited by the Authority, which are addressed in turn below.

1. The use of a Monte Carlo method would require the regulator to form a view on the probability distribution for the estimator for each input.
2. Most regulators would consider that the parameter inputs they adopt in determining the WACC already contain a degree of conservatism. Accordingly, if Monte Carlo simulation were to be used, it would not be based on unbiased estimates of the parameters and on inputs that already contained an element of conservatism.

3. No evidence has been presented to suggest that this technique has been used by other regulators.
4. The use of Monte Carlo simulation is likely to add to the degree of subjectivity rather than reduce it.

6.1. Reasons 1 and 2

The use of a Monte Carlo method would require the regulator to form a view on the probability distribution for the estimator for each input; Most regulators would consider that the parameter inputs they adopt in determining the WACC already contain a degree of conservatism.

Reasons 1 and 2 have to be considered together because they are inconsistent. It is not possible to consider an estimate to be conservative without specifying the unbiased or "mid-point" estimate, as well as the distribution underlying this estimate. Put another way, in any decision in which the regulator states that it has adopted a conservative estimate for a parameter, there is an implicit assumption that this is above or below its unbiased estimate, and that the difference between the actual and unbiased estimate is an appropriate hedge against the risk of underinvestment. **That is, there is an implicit probability distribution already inbuilt into the regulator's decision. The only difference with our approach is that we state the range explicitly.**

6.1.1. Example - Market risk premium

The following example illustrates the point. It relates to the estimate for the market risk premium. But any other parameter could be used in the example, as can the WACC itself, which was the basis of the original submission by ENERGEX and Ergon Energy.

The Authority's estimate of the market risk premium is 6%. There are two alternative interpretations of this estimate, either it is the Authority's unbiased or "mid-point" estimate of the market risk premium - so there is a 50% chance that the true market risk premium is above or below 6% - OR this is a conservative estimate of the market risk premium, which is above the Authority's unbiased estimate. The only way this can be considered a conservative estimate is if (1) the Authority estimates some unbiased estimate that is less than 6%; and (2) the Authority determines that there should be some probability greater than 50% that 6% exceeds

the true market risk premium, and this can only be achieved by specifying a probability distribution. For instance, the Authority could say:

> *"Our unbiased estimate of the market risk premium is 6.0%, but we have selected 7% for our estimation purposes. We consider that the true market risk premium is normally distributed with a mean of 6%, with a standard deviation of 1.8%, and have selected 7% as the market risk premium because this implies that there is only a 29% chance that our estimate is less than the true market risk premium."*

or, the Authority could say,

> *"Our unbiased estimate of the market risk premium is 6.0%, but we have selected 7% for our estimation purposes. We consider that the true market risk premium is uniformly distributed, within a range of 4-8%, and have selected 7% as the market risk premium because this implies that there is only a 25% chance that our estimate is less than the true market risk premium."*

However, without specifying a probability distribution or even a range, it is difficult to see how the parameter estimate can be considered conservative. In reaching the conclusion that the market risk premium is 6%, the Authority has not specified whether this is an unbiased or conservative estimate. But this is irrelevant to the point at hand. The conclusion remains the same: An estimate can only be considered conservative if this includes a comparison with the unbiased estimate (e.g., 6% versus 7%). And we can only assess just *how conservative* the estimate is with a probability estimate, which of course requires an assumed probability distribution.

6.1.2. The Alternative

What happens in the alternative case – making a conservative estimate without a probability distribution?

Now consider the alternative situation, where a conservative estimate is made without specifying a probability distribution. It is simply impossible to determine the degree of conservatism in this instance, and it is impossible to argue that this actually reduces subjectivity. How can a parameter estimate be considered conservative if the regulator does not state what it considers to be a high estimate, or a low estimate?

6.2. Reason 3

No evidence has been presented to suggest that this technique has been used by other regulators.

Evidence of use by other regulators, of course, is not a pre-condition for use of a new technique – otherwise no progress would be possible. Indeed, the Authority, through its recent review of WACC issues, has been at the forefront of ensuring that its procedures reflect current best practice.

In any event, we note that standard Monte Carlo simulation techniques *have* been used in relation to the estimation of WACC parameters in Australian regulatory settings. Indeed the Authority itself has used a similar methodology (in relation to estimation of benchmark capital structure) in the BRIA and GAWB determinations. The Authority also recognizes Monte Carlo simulation as an appropriate technique in relation to capital structure estimation in their response to the Lally Report in the DBCT Determination where they state that (p.177) that an optimal capital structure can be determined "by using simulation techniques," describing this as "a more sophisticated approach." Moreover, the Authority's engineering consultants have used simulation modeling extensively and this approach is referred to in three separate places in the DBCT Draft Determination alone.

6.3. Reason 4

The use of Monte Carlo simulation is likely to add to the degree of subjectivity rather than reduce it.

IT is difficult to understand how a simulation procedure adds to the subjectivity in estimating WACC. Regulators accept that the regulated WACC is only an estimate of the regulated entity's cost of funds, arrived at by assessing evidence on seven parameters - risk-free rate, debt premium, market risk premium, equity beta, leverage, corporate tax rate and the value of imputation tax credits – applying its judgement to the evidence presented in submissions, from other regulatory decisions and in the finance literature. This could be described as a subjective process because there is no simple formula to reconcile conflicting evidence. The regulator applies weights to difference pieces of evidence to determine a result.

But how does specifying probability distributions for the parameters make this a more subjective approach? All the distributions do is provide a mechanism for determining the weight placed on different evidence. For example, in estimating a parameter with a uniform distribution, the regulator is assuming that each point within a range carries equal weight in decision-making; in estimating a parameter with a normal distribution, the regulator is assuming that points closer to the mean carry greater weight than points further away; and in estimating a parameter with a gamma distribution, the regulator is assuming that points above the median carry greater weight than points below the median.

Specifying probability distributions can in no way increase the subjectivity with which parameters are estimated. They simply provide a clear mechanism for weighting alternative pieces of evidence. For example, consider the following two statements.

> *"Based on a survey of a range of estimation methodologies, Lally concluded that the Authority's current [market risk premium] estimate of 6 percent was reasonable in light of the Officer CAPM."*[14]

Or

> *"we propose that the market risk premium be modelled as normally distributed with a mean of 6.0% and standard deviation of 1.8%."*[15]

Both statements recognise that the market risk premium estimate of 6% is not estimated precisely, and both arrive at the same point estimate for the market risk premium. But the second statement makes the further assumption that the mean estimate is normally distributed with a standard deviation of 1.8%, based on historical data. In determining the estimated WACC, this implies that observations closer to the mean of 6% carry more weight than observations further away.

In contrast, the first statement is silent on the distribution of the market risk premium. This does not reduce the degree of subjectivity. It is equivalent to the regulator placing 100% weight on its point estimate of 6% and 0% weight on any alternative observation from the unspecified distribution. In application, this is equivalent to an assumption that the standard deviation of its market risk premium is 0.

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[14] *QCA: Regulation of Electricity Distribution, Draft Decision, December 2004.*
[15] *Energex/Ergon Energy submission*

By basing its regulatory decisions simply on point estimates for underlying parameters, the regulator has determined that the probability distribution underlying these parameters is irrelevant. The decision that the underlying distribution of parameter estimates, which, when applied, effectively imposes a standard deviation of zero on all parameters, involves at least as much subjectivity as specifying probability distributions.

Finally, it should be noted that **the Authority can easily recognise the effect of parameter estimation uncertainty squarely within its current framework and procedures.** The Authority can continue to select point estimates for each parameter and to estimate a point estimate for the WACC. The simulation approach can then be used to quantify the probability that this regulatory WACC provides the business with a return that is sufficient to meet its cost of funds. The Authority has already identified parameter ranges (in order to consider that a particular point estimate is "conservative") and the simulation approach is straightforward to implement. Thus, the approach is not costly to implement and we would be happy to assist the Authority in this regard. Moreover, quantifying the probability that the assigned regulatory WACC is sufficient to meet the DNSPs' true cost of funds is central to the implementation of the objectives spelled out in the Code. For example, a regulatory WACC that provides a 75% chance of meeting the true cost of funds is likely to be sufficient to provide "a sustainable commercial revenue stream," but a WACC that provides only a 25% chance does not.

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Appendix 1

Table 1: Summary of Proposed Changes to WACC Estimate

Parameter	QCA Draft Determination	Ergon Energy Proposal	Reason
Equity beta	0.9	1.0	ACG concludes that the equity beta of the average DNSP is 1.0. The reasons for choosing a higher value for Ergon Energy and ENERGEX are more concrete and unambiguous than any reason for choosing a lower value. Given the lack of precision of these estimates it is difficult to justify moving away from the average value of 1.0.
Tax rate	Effective (0%)	Statutory (30%)	The QCA is concerned that using the statutory rate results in a wealth transfer from consumers to DNSPs. The reverse is true. Using the effective rate transfers wealth from the DNSPs to consumers, and results in outcomes that differ from commercial outcomes. Using the effective rate destroys the value of one of the DNSPs assets: tax credits to be carried forward. Using the statutory rate does not produce a wealth transfer, it simply preserves the value of the DNSPs assets, consistent with commercial outcomes.
Link between γ and MRP	γ = 0.5, MRP = 6%, link not explicitly addressed.	The deterministic mathematical relationship of Officer (1994) should be preserved. This requires a reduction in γ, or an increased in MRP, or both.	It is inconsistent to assume that franking credits are valuable such that they reduce the corporate cost of equity, but then ignore them when estimating the MRP.
Framework for estimating γ	Endorsed Lally approach of assuming the value of γ would take if there were no foreign investment in the Australian market. $\gamma \approx 1$.	Reject the use of theoretical assumptions . Estimate γ as if it is, not as it would be in the absence of foreign investment. $\gamma = 0$.	All WACC parameters should be estimated with reference to market data, rather than assuming values. Other WACC parameters are influenced by foreign investment, why assume a value only for γ ? The only substantial study that uses data after the important tax law changes in 1997, and is peer-reviewed and published in a leading journal, suggests that an estimate of $\gamma = 0$ is appropriate.
Use of aggregate tax statistics to estimate γ	Distribution rate = 80%, utilization rate = 62.5%, γ = 0.5. Estimates based on Hathaway and Officer (1998, 2002)	Distribution rate = 71%, utilization rate = 50%, $\gamma = 0.35$	Hathaway and Officer (2004) present updated data and analysis. If this is the preferred method for estimating γ, 0.35 should be used, subject to being internally consistent with other WACC parameters. If not, the QCA should state which method is preferred and why.
Parameter estimation uncertainty	Single point estimates, some to three decimal places, are used for each parameter.	Recognize the uncertainty with which some WACC parameters are estimated and examine the impact on the estimated WACC using standard statistical techniques.	The code requirements include the provision of "a sustainable commercial revenue stream which includes a fair and reasonable rate of return" having regard to the "weighted average cot of capital applicable to the relevant network service." Ergon Energy and ENERGEX have proposed the use of standard statistical techniques to determine the probability that a particular regulatory WACC is sufficient to cover the DNSPs true cost of funds. This can be used by regulators to directly address the Code requirements. Indeed, it is difficult to see how the requirements of the Code are best met by ignoring this information.

Source: Queensland Competition Authority (2004) Draft Determination Regulation of Electricity Determination.