THE WEIGHTED AVERAGE COST OF CAPITAL FOR ELECTRICITY LINES BUSINESSES

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CONTENTS

EXECUTIVE SUMMARY

An earlier version of this paper was publicly released by the Commerce Commission (the Commission) on 31 January 2003. This final version supersedes that paper. In providing advice to the Commission in this paper, submissions received by the Commission on the earlier version of the paper, both in writing and orally at the Commission's conference (10-14 March 2003), have been taken into account and specifically addressed where required.

The Commission has recently (31 March 2003) made decisions on the thresholds to apply as part of the regulatory regime for electricity lines businesses (Lines Businesses), which the Commission was required to develop under Part 4A of the Commerce Act. As part of those decisions, the Commission decided not to adopt a profit threshold, although it has left open the prospect of such a threshold if work related to resetting the price path threshold (to apply from 1 April 2004), in conjunction with other parts of the regime, cannot satisfactorily limit the ability of Lines Businesses to extract excessive profits.

If a profit threshold is adopted and, at the end of the review period associated with that threshold, profits are found to be in excess of the threshold, then further investigation of profits may be undertaken. Furthermore, even if the Commission does not adopt a profit threshold, an examination of profits may be required anyway as part of an investigation by the Commission. Such investigations in turn may lead to the imposition of a price cap. All three of these possible regulatory steps (adoption of a threshold, investigation of profits, and imposition of a price cap) require an estimate of the Weighted Average Cost of Capital (WACC) for Lines Businesses and decisions about how the WACC would be employed to measure excess profits. This paper provides advice to the Commission on WACC issues applicable to each step, assuming for the purposes of this advice that each step is undertaken.

The primary conclusions are as follows. Regarding the estimation of nominal WACC for setting a profit threshold, the model recommended is that used in the Airfields Report. In addition the parameter values recommended are a market risk premium of 7% along with bands of 6-8% (compared to 7-9% in the Airfields Report), use of the

three year risk free rate (although there are pragmatic advantages to using the rate corresponding to the period of the profit examination), an asset beta for all of the Lines Businesses of .40 with bands of .30-.50, leverage of .40, and a debt premium of 1.2%. The form of ownership of the Lines Businesses should not be a factor in estimating the WACC, except in so far as it affects the asset beta, and this appears impossible to quantify. Using these parameter values, and the three (or five) year risk free rate of 5.5% (March 2003 average), the lower limit on WACC, the point estimate, and the upper limit are 5.8%, 6.8% and 8.0% respectively. If a Lines Business were subject to the possibility of assets being optimised out of the costs used to evaluate excess profits, as in the ODV asset valuation methodology, then some form of ex-ante compensation would be indicated, such as a "margin on WACC". Similarly, if it were subject to the possibility of costs associated with stranded assets being removed from the cost base used to determine excess profits, then again some form of ex-ante compensation would be indicated.

In respect of employing the WACC to determine a profit threshold, and then to examine whether breaches have occurred, two approaches are suggested. The first is to calculate the Excess Earnings for each year, and then compound these forward to the date of the review, as in the Airfields Report. The second is a variant on the IRR methodology, involving calculation of the premium earned relative to the cost of capital. The use of compounded Excess Earnings has the advantage of expressing the outcome in dollar terms, and the contributions of individual years to any breach are immediately apparent. The use of an IRR premium has the advantage of expressing the outcome in rate of return terms. In applying either of these methods, the issue of asset revaluations arises, and the conclusions reached in the Airfields Report are affirmed. In particular, land revaluations must be incorporated into the evaluation of excess profits, regardless of whether the Lines Businesses have recognised them in setting their output prices; failure to do so will lead to inappropriate conclusions. By contrast, in respect of revaluations for other assets, they should be included or excluded from the measurement of excess profits according to whether the Lines Businesses have included or excluded them in setting their output prices. Depreciation should be treated in the same way as the revaluations on depreciating assets, i.e., the numbers used should accord with those reflected in the Lines Businesses output prices. If a Lines Business is evaluated against an ODV asset valuation base, any resulting optimisations should not be included within "Revaluations" in the definition of Excess Earnings. Similarly, if stranded assets are removed from the cost base in determining Excess Earnings, these events should not be included within "Revaluations" in the definition of Excess Earnings.

If a profit threshold is implemented, and it is determined that a breach has occurred, further investigation may then occur into past and prospective profits. In carrying out this second step, the same principles used in the first step should be observed, with three exceptions. Firstly, in conducting further investigations, and providing that the Lines Businesses actual costs are examined rather than efficient costs, it would be appropriate to acknowledge the Lines Businesses actual leverage level, along with a compatible debt premium. Secondly, the bands of uncertainty around projected revenues and costs should be larger than for past revenues and costs. Finally, the bands in respect of WACC and joint cost allocations may differ from those in the first step, on account of the presence of more data (which leads to a narrower band) and the need to reduce the set of possible breaches (which leads to a wider band).

Having carried out these investigations, a price cap may then be imposed upon a Lines Business. In doing so, the WACC estimate employed may differ from that used in the earlier two steps, and the points of difference are as follows. First, the imposition of a price cap may change the appropriate asset beta for the Lines Business. In particular, the use of a five year regulatory cycle implies a larger asset beta than before the imposition of the price cap. Second, the bands around WACC must now be replaced by a point estimate. Third, the term of the risk free rate must accord with the term of the price cap. Fourth, the choice of actual versus optimal leverage (and the associated debt premium) may differ. Finally, in respect of asymmetric risks, the Commission would have to decide whether to incorporate an ex-ante allowance for them into the Lines Businesses output price, or offer ex-post compensation in the event of relevant events occurring.

1. Introduction

The Commerce Commission (the Commission) has recently (31 March 2003) made decisions on the thresholds to apply as part of the regulatory regime for electricity lines businesses (Lines Businesses), which the Commission was required to develop under Part 4A of the Commerce Act. As part of those decisions, the Commission decided not to adopt a profit threshold, although it has left open the prospect of such a threshold if work related to resetting the price path threshold (to apply from 1 April 2004), in conjunction with other parts of the regime, cannot satisfactorily limit the ability of Lines Businesses to extract excessive profits.

If a profit threshold is adopted and, at the end of the review period associated with that threshold, profits are found to be in excess of the threshold, then further investigation of profits may be undertaken. Furthermore, even if the Commission does not adopt a profit threshold, an examination of profits may be required anyway as part of an investigation by the Commission. Such investigations in turn may lead to the imposition of a price cap. All three of these possible regulatory steps (adoption of a threshold, investigation of profits, and imposition of a price cap) require an assessment of the Weighted Average Cost of Capital (WACC) for Lines Businesses and decisions about how the WACC would be employed to assess excess profits. This paper provides advice to the Commission on WACC issues applicable to each step, assuming for the purposes of this advice that each step is undertaken.

In light of this, the paper commences in section 2 with an estimate of WACC for the purposes of setting a profit threshold. Section 3 then examines the question of how that WACC is employed to set a profit threshold. Section 4 examines what changes might be needed in the context of a further investigation of profits. Finally, in section 5, the estimation of WACC is reassessed in the context of setting a price cap.

2. Estimating WACC in the Context of a Profit Threshold

This section estimates the WACC for Lines Businesses, in the context of estimating excess profits. This exercise parallels that conducted for the airfield operations of New Zealand's international airports (Commerce Commission, 2002a). Accordingly, the latter analysis will be used as a starting point. The conclusions reached there concern six issues: the model used, the market risk premium in the cost of equity capital, the risk free rate, the asset betas, leverage, and the debt premium. These issues are now discussed in turn. This is followed by discussion of two further issues: using WACC to allow for various asymmetric risks faced by Lines Businesses, and whether the form of ownership of the Lines Businesses is relevant to the estimation of their WACC. Nominal WACC estimates are then offered. Finally, these parameter values are compared with those recently favoured by Australian regulators.

2.1 The Choice of Model

In the Airfields Report, the cost of capital was generally agreed by the parties to be a weighted average of the costs of debt and equity, i.e.

$$WACC = k_e(1-L) + k_d(1-.33)L \tag{1}$$

where k_e is the cost of equity capital, k_d the current interest rate on debt capital, and L the leverage ratio. It was also generally agreed that k_d should be estimated as the sum of the current riskfree rate (R_f) and a premium (p) to reflect marketability and exposure to the possibility of default, i.e.,

$$k_d = R_f + p \tag{2}$$

In respect of the cost of equity, it was generally agreed that it should be determined by a simplified version of the Brennan-Lally version of the Capital Asset Pricing Model, i.e.,

$$k_e = R_f(1-T_I) + \phi\beta_e \tag{3}$$

where T_I is the average (across equity investors) of their marginal tax rates on ordinary income, ϕ the market risk premium, and β_e the beta of equity capital. This model is a simplified version of that in Lally (1992) and Cliffe and Marsden (1992), in which it is assumed that capital gains taxes are zero, that firms attached maximum imputation credits to their dividends, and that shareholders can fully utilise the imputation credits. It was further generally agreed that the parameter T_I was .33, implying an average (across equity investors) of their marginal tax rates on ordinary income of 33%. With these taxation assumptions, the market risk premium in equation (3) becomes

$$\phi = k_m - R_f(1-.33) \tag{4}$$

where k_m is the expected rate of return on the market portfolio.

In respect of the equity beta, this is sensitive to the leverage ratio L, and it was generally agreed that the relationship is

$$\beta_e = \beta_a\left[1+\frac{L}{1-L}\right] \tag{5}$$

where β_a is the asset beta, i.e., the equity beta in the absence of debt.

Equations (1) and (2) accord with generally accepted practice. In respect of equation (3), there are alternative specifications of the cost of equity capital. These include the standard version of the Capital Asset Pricing Model (Sharpe, 1964; Lintner, 1965; Mossin, 1966), the Officer (1994) model, and models that recognise international investment opportunities (for example, Solnik, 1974). However, equation (3) is commonly used in New Zealand, and was recommended by all parties to the airfields inquiry. In respect of the present situation, equation (3) is also used by most Lines Businesses. For example, of six businesses examined, three use equation (3) with a value for T_I of .33, a further two used equation (3) with a value for T_I of .28, and the remaining company (Transpower) adopted a modest variant on equation (3) along with a value for T_I of .20[1].

Equation (3) is clearly a better reflection of the personal tax regime operating in New Zealand than the standard or Officer versions of the CAPM, since the former assumes

[1] These companies are Buller Electricity, Counties Power, Dunedin Electricity, United Networks, WEL Networks and Transpower respectively. The modest variant in Transpower's case is the allowance for dividend tax being less than that on capital gains (the adjustment is a mere 0.14%).

that all forms of personal income are equally taxed and the latter assumes that interest and capital gains are equally taxed. In comparing equation (3) with international versions of the CAPM, the former assumes that national equity markets are completely closed whilst the latter assumes that they are completely integrated. The truth is clearly between these two extremes. However, in using an international version of the CAPM, estimates of the parameters needed are much less reliable than their domestic counterparts and there is no consensus on them or even of the particular model that should be used. In view of all this, the continued use of equation (3), with a value for T_I of .33, is recommended. The use of equation (5) is a logical consequence of the use of (3). Consistent with this, all six companies of the Lines Businesses referred to above invoke equation (5).

In the submissions presented to the Commission, the only deviation from the above model was in respect of equation (3). PricewaterhouseCoopers, hereafter PwC (2003a) argued for recognising capital gains and for an ordinary tax rate equal to the highest statutory rate. In respect of the capital gains tax issue, it is clear that some investors are subject to this tax and I have suggested estimates in my own work (Lally, 2000; Lally and Marsden, 2003). However the effect on WACC is likely to be slight[2]. Consequently, the simplifying assumption that capital gains tax is zero is favoured. In respect of using the top marginal tax rate, the tax-adjusted CAPM requires weighting across all investors holding the market portfolio and these weights are essentially market value weights. PwC (2003b) present evidence from the US that the typical investor in shares faces a higher marginal tax rate than the typical investor in bonds or the typical taxpayer in general. They also present evidence from the US, Australia and New Zealand that equity holdings by individuals are highly concentrated amongst the wealthiest individuals, who in turn are likely to be taxed at the highest marginal rate. However the analysis in Lally and Marsden (2003), conducted upon New Zealand income and taxation data, points to an average (across equity investors) of their marginal ordinary tax rates of about .33 rather than the top

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[2] The effect will depend upon the way in which the market risk premium is estimated. Suppose the latter is estimated by the forward-looking approach. Then, for a company with an equity beta equal to 1, the effect of varying the assumption about capital gains tax is nil, due to the offsetting effect in the market risk premium. With a beta less than one, the effect is to reduce the WACC. For example, with an equity beta of .67 as suggested later in this paper, and an average tax rate on capital gains of 25% of the ordinary rate, the effect is a reduction of less than .05%.

rate of .39, even in the absence of avoidance or evasion. Furthermore, for the same reasons applying to the capital gains tax issue, the effect is likely to be slight. In view of all this, the assumption of a current average (across equity investors) marginal tax rate on ordinary income of .33 is favoured.

2.2 The Market Risk Premium

The market risk premium in equation (4) can be estimated in a number of ways, including historical averaging of the Ibbotson (2001) and Siegel (1992) types, the constant reward to risk methodology of Merton (1980), forward-looking approaches (as in Cornell, 1999, Ch. 4, and Claus and Thomas, 2001), and survey evidence. The pros and cons of these approaches are discussed in Lally (2001a). The Airfields Report (Commerce Commission, 2002a) favoured an estimate of .080. This reflected estimates arising from three of these methodologies for which New Zealand data was available, coupled with estimates from two methodologies using foreign data (on the grounds that there was no such New Zealand data or that it was problematic). The first of these involved historical averaging of the Ibbotson (2001) type, and yielded an estimate of .082[3]. The second approach applied the same methodology to the standard market risk premium in other markets, and then corrected for the difference in the definitions of the market risk premiums, yielding an estimate of .094[4]. The third approach (Credit Suisse First Boston, 1998) invoked the methodology of Merton (1980), and generated an estimate of .075[5]. The fourth approach was a forward-looking one of the Cornell (1999, Ch. 4) type, and generated an estimate of .076. The last approach invoked US survey evidence on the standard market risk premium;

[3] This figure is based on the results of PwC (2001), with a small correction for a difference in taxation assumptions to align it with equation (4). More recently, PwC (2002) have lowered their estimate to .075, which corresponds to an estimate of about .077 for the market risk premium in equation (4).

[4] The data invoked is that of Dimson et al (2000), who generate estimates of the standard market risk premium for twelve markets, using data from 1900-2000 and long term bonds (averaging around ten years). The median of these estimates is .071. Correction for the difference in the definitions of the market risk premium raises this to .094 (Lally, 2001a). However the latter correction involves the prevailing risk free rate. Since the ten year risk free rate is .060 (March 2003 average), this converts the .071 to .091 rather than .094.

[5] Estimates over the preceding few years generated an average that was similar to this. However the estimates do not reflect the taxation assumptions of equation (4), most particularly in assuming a tax parameter of .20 rather than .33. Given a ten year risk free rate of around .06 in 1998, the implied value for the market risk premium in equation (4) is about .083.

correcting the result for the difference in the definitions of the market risk premiums yielded an estimate of .083.

Recently, further papers on this issue have become available, which offer improvements on the first, fourth and fifth of these approaches. In addition, data relating the Siegel (1992) approach is now available. In respect of conventional historical averaging of the Ibbotson type, Lally and Marsden (2003) have done so and obtain an estimate of .073, compared to the figures of .082 and .077 referred to above (based on the work of PwC, 2001, 2002). The work of Lally and Marsden (2003) parallels the work of PwC, but has the advantage of actually estimating the average tax rate on dividends rather than simply assuming that the top rate applies; accordingly it is preferred. In respect of the forward-looking approach, Lally (2001b) applies this methodology and obtains estimates for the market risk premium of .058-.079 compared to the figure of .076 above. However these numbers are defined relative to the five year bond rate; if they were defined relative to the ten year rate, for comparability with the Lally and Marsden (2003) estimate, then the range would be .054-.075. This forward-looking analysis is more sophisticated than that reflected in the figure of .076, and therefore is preferred. In respect of the US survey based evidence, this is based on the work of Welch (2000), who obtains an estimate for the market risk premium in the standard CAPM of .06 (measured relative to ten year bond yields). However, in a more recent survey, Welch (2001) reports a figure of .055 measure relative to short-term bonds. At the time of the survey (August 2001), US ten year bonds were offering about .015 more than short-term bonds[6]. So, measured relative to US ten year bonds, Welch's survey evidence implies a figure of about .040. Corrected for the difference in definitions of the market risk premium, using a ten year risk free rate of .060 (March 2003 average), this implies an estimate for the market risk premium in equation (4) of .060.

Finally, the new class of evidence referred to is application of the Siegel (1992) methodology to New Zealand data. Siegel analyses real bond and equity returns in the US over the sub-periods 1802-1870, 1871-1925 and 1926-1990. The real returns on long-term government bonds were .052, .040 and .018 respectively, whilst real

[6] The data is drawn from the website of the Federal Reserve.

equity returns were similar across the sub-periods (.069, .079 and .086 respectively). The result is an Ibbotson type estimate of the standard MRP that is unusually high using data from 1926-1990. Siegel argues that the very low real returns on bonds in that period were due to pronounced unanticipated inflation. Consequently the Ibbotson type estimate of the standard MRP is biased up when using data from 1926-1990. Thus, if the data used is primarily from that period, then this points to estimating the standard MRP by correcting the Ibbotson type estimate through adding an estimate of the long-term real risk free rate net of the historical average. Siegel suggests a figure of .03-.04 for the long-term real risk free rate, and this is consistent with the current rate in New Zealand. Applying this approach to New Zealand data, Lally and Marsden (2003) obtain an estimate for the tax-adjusted market risk premium of .053-.060. Correcting these numbers, for consistency with the tax assumptions of equation (4), the result is .054-.061.

To summarise, conventional historical averaging of the Ibbotson type yields .073, historical averaging of the Siegel type yields .054-.061, application of the Merton (1980) methodology yields .083, application of the Cornell forward-looking approach yields .054-.075, Ibbotson type estimates from other markets suggests .091, and US survey based evidence pointed to a figure of .060. All of these figures reflect a long-term risk free rate (around ten years), and they are all consistent with the taxation assumptions reflected in equation (4). The simple average of these six estimates is .072. If the foreign data is excluded, on the grounds of being less relevant, then the figure falls to .070. All of these numbers invoke the ten year risk free rate, and it not apparent that this is the correct horizon. If the five year rate was used instead then, on the basis of the current differential between New Zealand five and ten year bond yields (.005), the estimate of the market risk premium would rise by .003[7]. Thus, a simple average of the six approaches would yield .075, and exclusion of the foreign data would yield .073. Finally, all methods assume that there is no evasion or avoidance of taxation, and allowance for such will modestly reduce the estimates. I do not believe that accuracy in this area is attainable to more than two decimal points. Accordingly, I favour an estimate of .07, with bands from .06 to .08.

[7] Such a correction will only be appropriate for the second and fourth of these six methods. In respect of the sixth method, the correction would be of the same type and would also raise the risk free rate by .005 (March 2003 mean: data from the Federal Reserve website), yielding the same increment of .003 in the estimate of the market risk premium. I am unable to adjust the results for the other methods.

This estimate of the market risk premium is obtained using data available at the present time. If one estimates the WACC for earlier years, the question of whether this estimate for the market risk premium is equally applicable to these earlier years arises. Of the estimation methods used, all but the forward-looking approach and the results from US surveys are not particularly sensitive to re-estimation of the parameter a few years earlier. In respect of the forward-looking approach, the analysis has not been conducted for earlier years. Finally, in respect of the results from US surveys, these are only available at two points in time (1997 and 2001). All of this suggests that the estimate for the market risk premium should not be adjusted when WACC is estimated for earlier years.

Amongst the submissions presented to the Commission, a number of the Lines Businesses or their advisors have argued for a higher estimate than .070. Emanuel (2003a) favours a figure of .08 rather than .070. His reservations about the figure of .070 seem to at least partly reflect a belief that the figure of .070 is based primarily upon the results from Lally and Marsden (2003). In fact, as indicated above, the figure of .070 is based upon a consideration of the results from six distinct approaches. Emanuel (ibid) also favourably cites the figure of .094 (now adjusted to .091) appearing in the Airfields Report (Lally, 2001a), being the result from applying historical averaging to a number of foreign markets. However this figure of .091 is reflected in my conclusion of .070, being the result from one of the six approaches invoked.

Emanuel (2003b) also argues for wide bounds on the point estimate for WACC, of plus and minus .028, reflecting two standard deviations around the point estimate of the market risk premium from historical averaging methodology. This contrasts with my suggested bounds on the market risk premium of plus and minus .01, implying bounds on WACC of plus and minus .008. My principal reservation with Emanuel's suggestion is that it assumes that the market risk premium has been estimated exclusively by the historical averaging methodology. This is not the case. It has been estimated by considering the results from six different approaches, and this offers considerably more confidence in the point estimate than would be appropriate if it arose from considering only one approach.

Dunedin Electricity (2003) argues for a market risk premium of .075, on the basis that this figure is favoured by PwC (2003a); the evaluation of this figure is then dealt with by examining the latter's reasoning. PwC (2003a) favour a figure of .075, based primarily upon the results of their own application of historical averaging methodology using New Zealand data (PwC, 2002). As noted by LECG (2003), the assumptions about capital gains tax involved here differ from those in equation (4), and correction for such raises their number to about .077. The PwC number is also defined relative to one year bonds rather than the ten year bonds assumed in my analysis, and correction for this might change the PwC number (although I cannot determine the size of the adjustment). However, since their figure places no explicit weight upon other estimation approaches, I do not favour it. Nevertheless, even if it were invoked in substitution for the Lally and Marsden (2003) figure of .073, it would raise the average of the results across the six approaches examined by only .001, too little to change the conclusion of .070.

PwC (2003d) also examine the six approaches considered by me, and suggest some modifications to some of the results, thereby generating an average across the six approaches of .076. However all of these figures must be adjusted. First, the historical averaging result of Lally and Marsden (2003) has been adjusted from .071 to .073[8]. Second, the result of historical averaging from foreign markets has been altered from .094 to .091, as noted in footnote 4. Third, the Merton type result ascribed to me has been revised from .075 to .083, as discussed in footnote 5. Fourth, the forward-looking numbers cited of .058-.079 should be reduced to .054-.075, as described on page 10. Fifth, the Welch survey result of .062 is raised by PwC to .066, on the grounds that the fall in the US market since it was undertaken *may* now have caused the respondents to raise their estimate. This is pure conjecture, and should not be entertained. Finally, the Siegel type results of Lally and Marsden (2003) are now .054-.061, as described on pages 11-12. This in turn alters the PwC figure of .055 to .058. Correcting for these points, PwC's average would then be .074 and mine would now be .072.

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[8] This adjustment arises in recognition of PwC's argument (2003b) that the "market" portfolio is shares rather than shares and bonds.

Most of the remaining difference between this figure of .074 and my average of .072 is attributable to PwC adjusting the results of Lally and Marsden (2003), of both the Ibbotson and Siegel type, to reflect PwC's belief about a tax issue. In particular, they argue that the applicable marginal tax rate on ordinary income for investors holding shares is equal to the top statutory rate rather than the "median" rate used by Lally and Marsden. In support of this, they point to the concentration of equity holdings amongst a small proportion of (presumably very wealthy) investors, and they present US evidence that the typical investor in shares faces a higher marginal tax rate than the typical investor in bonds or the typical taxpayer. They claim that the use of the top statutory rate would raise the Ibbotson type estimates of Lally and Marsden by .014. However, in acknowledging PwC's (2003b) argument that the "market" portfolio is shares rather than shares and bonds, Lally and Marsden (2003) have now redone their analysis, and their estimate thereby rises from .071 to .073. In doing so, they accessed New Zealand information on the tax rates applicable to dividends for the years 1959-83, and extrapolated such results to the remaining years. Contrary to PwC's contention, this information reveals that most dividends are not taxed at the top marginal rate.

LECG (2003) argue for a market risk premium of .090, on the grounds that historical averaging is the best methodology, that New Zealand data of this kind is ruled out by the highly controlled nature of the economy prior to the mid 1980s, and therefore US data is invoked. This consists of two steps. First, they invoke the .070 result from Dimson et al (2000), which is an estimate of the market risk premium in the standard CAPM. This implies an estimate for the market risk premium in equation (4) of .090. The deficiencies in alternative estimation approached are noted, in support of this reasoning. However the approach fails to note the deficiencies in historical averaging methodology (see Lally, 2001a). In my view all approaches to estimation are imperfect, and this argues for considering all of them. At one point LECG do suggest a range of .080-.090, in recognition that alternative approaches produce "significantly lower estimates". However they later choose a midpoint WACC estimate that reflects the .090 estimate for the market risk premium. Even leaving aside the New Zealand data that I have drawn upon, examples of US studies that yield significantly lower estimates of the US market risk premium (defined against long-term bonds) than the .070 recommended by LECG are Fama and French (2002), who obtain .026-.043

(defined against short term bonds, implying less than this against long-term bonds), Claus and Thomas (2001), who obtain .034, and Jagannathan et al (2001), who obtain .013. In addition, and presumably in recognition of studies of this kind, the Welch (2001) survey result for the US yields an estimate of .040 (defined against long-term bonds, as derived earlier). LECG give no weight to these results.

NECG (2003a) argue for an estimate of .10[9]. Like LECG, they argue that historical averaging is best, that New Zealand data of this kind is ruled out by the highly controlled nature of the economy prior to the mid 1980s, and therefore US data is invoked. Their process involves four steps. First, they start with a point estimate for the standard market risk premium, defined relative to short-term government bonds. The Ibbotson Associates (2001) result of .088 is cited, and then subjectively reduced to .065 in recognition of alternative approaches using US data that yield lower results (such as Welch, 2001). Second, this is increased by .02 to reflect the conversion to the market risk premium in equation (4). Third, this is further increased by .030 to reflect differences between US and New Zealand stocks. Finally, this point estimate is reduced by .015 to convert it to an estimate defined relative to long-term government bond yields. The fundamental difficulty with this approach is that it utilises only US data and it is neither transparent as to the studies that underlie the point estimate of .065 nor the relative weights given to them[10]. A rationale for excluding New Zealand historical data is offered but none for excluding the results from forward-looking or Merton (1980) type approaches using New Zealand data. My view is that all methods have their limitations, and therefore some (explicit) weight should be given to them all.

NECG (2003a) also argue that the estimate of .070 for New Zealand is inconsistent with the widely used estimate of .06 in Australia. The comparison requires two adjustments in their view. First, the figure of .070 must be reduced by .02 to yield an

[9] NECG (2003b) reduces this to .09, and the .09 figure also appears in NECG (2003a). It appears that the difference arises from whether the adjustment for country differentials is .02 or .03.

[10] In the course of responding to questions, Professor Bowman indicated that he placed no weight on forward-looking approaches using US data, such as those of Fama and French (2002), Claus and Thomas (2001) and Jagannathan et al (2001). All three studies yield numbers less than .05, defined relative to short-term bonds.

estimate of about .050 for the market risk premium in the standard CAPM. Secondly, the Australian figure of .06 is based on a long term risk free rate and must be raised by .01 to reflect a short term risk free rate, which would then be comparable to the New Zealand figure (allegedly based on Lally and Marsden, 2003, who use a short term risk free rate). Thus, with these adjustments, the New Zealand figure is .02 *smaller* than the widely used Australian figure, and this is implausible. I am broadly comfortable with the Australian figure of .060 (Lally, 2002) and with the view that the New Zealand market risk premium should be approximately equal to that for Australia[11]. However, there are errors and omissions in NECG's adjustments. First, the widely used Australian figure of .06 is not an estimate of the market risk premium in the standard CAPM but the Officer (1994) model. Like equation (4), the market risk premium in the Officer model contains tax parameter terms. Invoking the widely used estimates of these (see Lally, 2000, p 7), the Australian estimate of .060 implies an estimate of .055 for the market risk premium in the standard CAPM. Second, all of the numbers used by me in arriving at an estimate of .070 for the market risk premium in equation (4) are based on 10 year risk free rates, and are therefore comparable with the Australian number. Thus, the comparison should have been .055 in Australia with .050 in New Zealand. Thus, when the appropriate corrections are made, the Australian number is very similar to the number recommended here for New Zealand.

In summary, I do not consider that the arguments in these submissions warrant an increase in the estimate of .070 for the market risk premium in equation (4).

2.3 The Risk Free Rate

The choice of the risk free rate, being the first term in equation (3), involves two issues: the term of the risk free rate and the period of averaging. In respect of the latter, the implementation of a profit threshold on a particular date points to use of the risk free rate on that day. However, use of the rate on a single day yields exposure to a freakish one day rate. Accordingly, I favour averaging of the rate over the

[11] The markets differ in respect of taxation and risk. The former drives up the Australian market risk premium relative to New Zealand but the latter drives it down. These issues are discussed in more detail in section 2.10.

preceding month. NECG (2003b) argue for using the rate on the date of implementation, but nevertheless accept the merits in a limited amount of averaging.

Turning to the choice of term, the assessment of excess profits over a particular period might suggest that the appropriate term for the risk free rate matched that review period. However, as shown in Lally (2002a), the appropriate term is that ensuring that the present value of the future cash flows equals the initial investment, and this implies that the appropriate term is that matching the period for which output prices are set. This is quite distinct from the period over which excess profits will be assessed. The latter period is not even apparently driven by the former; instead, the latter period represents a trade-off between the need for forming a view quickly and allowing sufficient time to pass to mitigate the effects of unrepresentative events.

Regarding the period for which output prices are set, in the case of the airfields this was judged to be three years in some cases and five in others. In respect of the Lines Businesses there has been neither explicit regulation nor even informal understandings as to the frequency with which prices are reset. The Commission's decision to adopt a price threshold does not change this. Thus, one either waits until the end of the review period for excess profits, and retrospectively chooses the appropriate risk free rate term based upon the observed frequency of price resets over the review period, or forms a view (at the point of implementing the profit threshold) about the likely frequency of price resets. I think it reasonable to declare the rate against which businesses will be assessed before rather than after the fact, and this favours forming a view about the frequency of price resets at the time of implementing the profit threshold. The feasible candidates are in the 1-5 year range, and I choose the midpoint of three years. So, this points to using the three year risk free rate. This would be set at the beginning of the review period (i.e., the month preceding it), and then reset in three years at the three year rate prevailing then.

Notwithstanding these conceptual arguments in favour of using the three year rate, and assuming that the review period for excess profits is longer than three years, the need to reset it in three years is cumbersome, and can be avoided by using the rate corresponding to the length of the review period for excess profits. At the present time, there is little difference in the 2-5 year rates (although the situation in three years could be different in the sense that the three year rate may change over that period).

A number of submissions (Dunedin Electricity, 2003; PowerNet, 2003) have argued that WACC should be revised more frequently than this, but on the grounds that interest rates change rather than to reflect the frequency with which prices are reset. However, the fact that interest rates change is immaterial to the reasoning on this question in Lally (2002a). A number of other submissions have argued for the ten year risk free rate, primarily on the grounds that this better matches the duration of the firm's assets (Brook Asset Management Ltd, 2003; NECG, 2003a; LECG, 2003). However, to support any conclusion in this area, it is necessary to show that the resulting present value of the future cash flows matches the initial investment (as in Lally, 2002a). None of these contrary submissions show that their preferred term for the risk free rate satisfies this requirement. Furthermore only NECG (2003a) challenges the reasoning on this question in Lally (2002a), by observing (correctly) that the latter paper disregards risks other than interest rate changes and then arguing that recognition of other such risks would invalidate the conclusion. However no proof is offered for this argument and Lally (2002c) shows that recognition of such risks has no effect upon the conclusion.

That the duration of a firm's assets should not govern the choice of the risk free rate term can be demonstrated through an example appearing in Lally (2001a). Suppose that the period for which prices are set is five years commencing now, i.e., from time 0 till time 5. In five years, prices will be reset then for a further five years, and so on. The duration of the firm's assets is ten years. Also, suppose that the five year bond rate is currently 5% and the ten year bond rate is currently 7.5%, the latter due to expectations that interest rates in five years will be 10%. Suppose these expectations are vindicated in the sense that, in 5 years, the bond rate is 10% for all terms to maturity. If prices were set using the risk free rate matching the period for which prices are fixed, then a rate of 5% would be used for the next five years, followed by the use of 10% thereafter. By contrast, if prices were set using a rate matching the asset duration, the rate used would be 7.5% for the first five year period, followed by 10% thereafter. The latter approach then leads to double-dipping in the sense of the firm being rewarded for future high interest rates not only when they occur but also in anticipation of it.

Finally, some submissions argue for matching the risk free rate term used for the first term of equation (3) with that used in estimating the market risk premium (LECG, 2003; MEUG, 2003). However, Lally (2002a) shows that this is not necessary when the CAPM is applied to a succession of future periods rather than to the single period matching the assumed investor horizon in the model.

2.4 Asset Betas

The assessment of an appropriate asset beta should arise from a consideration of the factors underlying asset betas. Lally (2001a) discusses these factors at some length, and they are as follows.

The first factor is industry, i.e. the nature of the product or service. Firms producing products with low income elasticity of demand (necessities) should have lower sensitivity to real GNP shocks than firms producing products with high income elasticity of demand (luxuries), because demand for their product will be less sensitive to real GNP shocks[12]. Rosenberg and Guy (1976, Table 2) document statistically significant differences in industry betas after allowing for various firm specific characteristics, and these differences accord with intuition about the income elasticities of demand. For example energy suppliers have particularly low betas whilst recreational travel is particularly high.

The second factor is the nature of the customer. There are a number of aspects to this. One of them is the split between private and public sector demand. Firms producing a product whose demand arises exclusively from the public sector should have lower sensitivity to real GNP shocks than for firms producing a similar product demanded exclusively by the private sector, because demand should then be less sensitive to real GNP shocks. A second aspect of customer composition is the residency mix,

[12] Real GNP shocks are unexpected changes in real GNP, of any duration.

although this has no implications for the Lines Businesses[13]. A third aspect of customer composition is the personal/business mix, with the latter being more sensitive to GNP shocks in the case of Lines Businesses[14].

The third factor is pricing structure. Firms with revenues comprising both fixed and variable elements should have lower sensitivity to real GNP shocks than firms whose revenues are entirely variable. Such fixed components are embodied in the revenues of Lines Businesses.

The fourth factor is the duration of contract prices with suppliers and customers. The effect of this on beta will depend upon the type of shock and the firm's reaction to it in the absence of a temporarily fixed price. For example, in the absence of any such restrictions on prices, and in the face of a positive economy-wide demand shock, a profit maximising monopolist will increase its output price. An output price that is contractually fixed for some period prevents the firm from immediately acting in that way, and thereby reduces the firm's beta. By contrast, in the presence of an adverse cost shock (which induces an adverse economy-wide reduction in output), the same restriction on output price also prevents a firm from immediately raising its output price to mitigate the adverse cost shock, and this magnifies its beta[15]. In respect of the Lines Businesses, long-term contracts exist with some of their customers, and in some cases with their suppliers (through direct means or through forward contracts with third parties).

The fifth factor is the presence of price or rate of return regulation. Firms subject to "rate of return regulation" (price regulation with frequent resetting of prices) should have low sensitivity to real GNP shocks, because the regulatory process is geared towards achieving a fixed rate of return. Rosenberg and Guy (1976, Table 2) find that

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[13] The demand for a product by foreign customers would have less sensitivity to New Zealand's GNP shocks than the demand from local customers. Instead, such demand from foreign customers would be sensitive to their own country's GNP shocks, and these are imperfectly correlated with those of New Zealand. Lines Businesses are characterised overwhelmingly by demand arising from local customers.

[14] This is because personal demand for electricity involves demand for an "essential" product. By contrast, in the case of air travel, the personal demand for it would have greater sensitivity to GNP shocks than business demand, because personal consumption of it is a luxury.

[15] In the case of a negative demand shock, a profit maximising monopolist would seek to reduce their price. In this case, a price fixed by contract would not restrict them from doing so.

such industries have amongst the lowest betas after allowing for various firm specific variables. However, as the reset interval increases, the adjustment of the output price so as to preserve the firm's rate of return is increasingly delayed; exposure to macro-economic shocks then increases, and this should raise the firm's beta. Consistent with this, Alexander et al. (1996) show that utilities subject to UK style regulation (in which prices are set for five years) have significantly larger average asset betas than for utilities subject to US regulation (in which prices are set for only one year). Lally (2002b) attributes part of the difference in asset betas to market leverage differences, but this still leaves a substantial residue, apparently attributable to the difference in regulatory regimes. In respect of the Lines Businesses, there are no price controls in force. However they have operated for some time in the knowledge that excess profits might induce price controls. In addition the Commission has decided to adopt a price threshold. Finally, this analysis of WACC is predicated upon the implementation of a profit threshold. These circumstances are likely to affect the behaviour of the Lines Businesses. However it does not seem possible to quantify these effects upon beta. Nevertheless the rank ordering seems clear. A price cap should exert the greatest effect, followed by a profit threshold with retrospective recouping of excess profits in the event of it triggering control, then a profit threshold with no such retrospective aspect, and finally the situation prior to the imposition of a threshold[16].

The sixth factor is the degree of monopoly power, i.e. price elasticity of demand. So long as firms act to maximise their cash flows, theory offers ambiguous results – Conine (1983) shows that the direction of impact depends upon firm specific characteristics including the sensitivity of demand for the firm's product to market shocks and the sensitivity of the prices of its inputs to market shocks. By contrast, if monopolists do not optimise their cash flow, in the sense of reacting to demand shocks by varying the cushion provided by suboptimal pricing and cost control more than do non-monopolists, then their returns should exhibit less sensitivity to demand, and hence to real GNP shocks. The empirical results in this area are equally mixed – Sullivan (1978, 1982) concludes that increased market concentration is associated

[16] The profit threshold discussed by the Commission involves a limited suggestion of a retrospective recouping of excess profits in the event of a price cap being imposed (Commerce Commission, 2002b, paragraph 78).

with lower asset betas whilst Curley et al (1982) finds no relationship. In respect of Lines Businesses, their monopoly power may be diluted by the countervailing power of their large customers. So, if monopoly power affects beta, then the effect of any such countervailing power would be to mitigate that beta effect[17].

The seventh factor is the extent of the firm's real options, most particularly the option to adopt new products. Myers and Turnbull (1977, pp. 331-2) note that the betas of firms will diverge from those of their individual projects if the firms have growth options. The existence of such growth options should increase the firm's sensitivity to real GNP shocks, as the values of these growth options should be more sensitive to real GNP shocks than firm's value exclusive of them, and these two value components should be positively correlated. Chung and Chareonwong (1991) model the relationship between beta and growth options, and find empirical support for a positive relationship. Black and Scholes (1973) show that the sensitivity of an option value to an underlying variable (and hence that of a firm possessing one) will vary with the term to maturity of the option and with how close it is to "the money". Prima facie, Lines Businesses do not have significant real options.

The eighth factor is operating leverage. If firms have linear production functions and demand for their output is the only random variable, then firms with greater operating leverage (higher fixed operating costs to total operating costs) should have greater sensitivity to real GNP shocks because their cash flows will be more sensitive to own demand, and hence to real GNP shocks. A number of papers including Rubinstein (1973), Lev (1974) and Mandelker and Rhee (1986) have modeled this. However the assumptions noted above, which underlie this work, are very restrictive. Booth (1991), by contrast, examines a perfectly competitive firm facing price uncertainty, and reaches the opposite conclusion about the sign of the relationship between operating leverage and beta. In respect of empirical work, Lev (1974) shows that operating leverage is positively correlated with equity beta, for each of three industries. Mandelker and Rhee (1974) refine the procedure and reach the same conclusion in respect of a set of firms spanning numerous industries. However Lev's conclusions are specific to the three industries examined. Furthermore Mandelker and

[17] The effect here would be much less than in the case of airfields, because airfields are characterised by a few very large customers.

Rhee's conclusions are at best valid for the majority of firms included in the data set, i.e. some industries may exhibit the opposite pattern but are outweighed in the data set. These concerns about lack of generality of the results are prompted and supported by the theoretical literature just surveyed. Nevertheless, the situation facing the Lines Businesses (which are local monopolists) would seem to correspond more to that modelled by Rubinstein et. al. than Booth, and this implies that their high operating leverage should magnify their asset betas.

The last factor is market weight. Increasing an industry's weight in the market proxy against which its beta is defined will draw its beta towards 1, although not necessarily in a monotonic fashion (Lally and Swidler, 2003). Even for a market weight as low as 5%, the effect can be substantial. Lines Businesses and possible comparators have limited weights in market indexes[18]. Consequently this point is not relevant.

With this background, I now turn to the question of estimates. The usual practice is to seek estimates from the firms themselves, and also from comparable companies suitably adjusted for sources of difference between them and the firms of interest. In respect of the firms themselves, only three of them are listed companies (PowerCo, Horizon Energy and United Networks). Furthermore, such beta estimates could only be used for the period since their energy businesses were sold, i.e., from 1999. Using OLS regression to estimate these equity betas β_e against the NZSE40 gross index for the period Jan 2000 – Jan 2003 yields the results shown in the table below. These figures must be stripped of leverage to yield estimates of the asset betas β_a. Equation (5) formalises the relationship between equity and asset betas, but it is only valid at a point in time. However the equity betas are estimated over a period of three years, and therefore reflect average debt/equity levels (B/S) over that period rather than current leverage[19]. The debt/equity levels for each firm, for each of these three years

[18] In respect of New Zealand, the weight of power companies in the NZSE40 index in 2001 was 3%.

[19] Lally (1998a) shows that substituting such averages into (5) yields a good approximation. He also observes that variation across time in market leverage is relevant, but data for this period is lacking and the variation over three years is unlikely to be substantial.

and the average, are shown in the table below[20]. Substitution of these estimated equity betas and average debt/equity levels into equation (5) then yields the asset betas indicated in the table below, with an average of .19. Given the small number of companies, no great reliance can be placed on this average result of .19.

		B/S				
Company	β_e	2000	2001	2002	Mean	β_a
PowerCo	.96	.89	.96	1.13	.99	.48
Horizon Energy	.32	.64	.67	n.a	.66	.19
United Networks	-.20	1.13	.69	.72	.85	-.10
Average						.19

I turn now to an examination of comparable companies. If the Lines Businesses operated in a largely cost-plus fashion (i.e., cost and volume shocks were rapidly transmitted to their customers) then they would closely resemble vertically integrated US firms in the electricity generation and distribution sector, which are subject to rate of return regulation with annual resetting of prices. These firms were considered in the Airfields Report (Lally, 2001a), and an asset beta of .30-.35 was attributed to them. This comprises an estimate of .25-.30 for their betas defined against a US index, subject to correction for differences in market leverage between the US and New Zealand (following the correction process in Lally, 2002b). The estimate of .25-.30 was largely based on Alexander et al (1996), using data for the period 1990-95. A more recent estimate for the US firms is .30 (Damodaran, 2002), which must be converted to a New Zealand equivalent[21]. Following Lally (2002b), conversion requires recent estimates of market leverages in the two markets and relevant tax parameters. Recent estimates for the leverages of the two markets are .26 for the US and .19 for New Zealand (Ernst and Young, 2000). In addition, the relevant tax parameters are .34 for the US (the corporate tax rate) and zero for New Zealand (due

[20] The debt levels are drawn from Financial Statements for those years, and the equity values are the product of share prices and number of shares outstanding (at the same time as the debt levels are observed).

[21] The Damodaran estimates are based on the preceding five years data and involve the results of standard regression analysis with no adjustments.

to dividend imputation). The asset beta estimate of .30 is then converted to a New Zealand equivalent of

$$\beta_a = .30\frac{\left[1+\frac{.26}{(1-.26)}(1-.34)\right]}{\left[1+\frac{.19}{(1-.19)}(1-0)\right]} = .30$$

Even more recently Damodaran (2003) has raised the estimate for the US firms to .37. Following the same conversion process above, this translates into a New Zealand figure of .37. Estimates of this type are subject to estimation error, and therefore one should weight the results from a variety of periods. Furthermore, precision beyond one decimal point is difficult to obtain. In view of this I recommend an estimate for the asset beta of the US firms of .30.

Since the Lines Businesses are not rate of return regulated, and face no explicit price controls, they could be expected to exploit their monopoly power at least to some extent. Point six above discusses the empirical and theoretical literature on the question of whether monopoly power affects beta, and no clear conclusion results. However the papers examined there compare monopolistic scenarios with other unregulated situations. The more interesting comparison here is with US rate of return regulated electricity companies, whose output prices are closely tied to costs. In the absence of explicit controls on their prices, the output prices of the Lines Businesses could be expected to conform less closely to their costs, and the effect of this would be to raise their asset betas.

An alternative comparator is UK price regulated firms in the electricity and gas generation and distribution sector, with five yearly price resetting, at least in the early 1990s[22]. These firms were considered in the Airfields Report (Lally, 2001a) and an asset beta of .20 more than the US firms was attributed to them. Lally (2002d) suggests that this figure of .20 is an upper bound on the appropriate increment, and my judgement is that the appropriate increment is .10-.20. In comparing the Lines

[22] From the mid 1990s these firms largely switched to revenue regulation (Alexander et al, 1996). This removed exposure to volume shocks and this should have led to lower asset betas.

Businesses (under a profit threshold) with the UK firms, the UK firms (but not the Lines Businesses) were unable to raise their prices within the five year regulatory cycle in response to cost increases or volume declines, and this fact would have led to them having higher asset betas than the Lines Businesses. In addition the UK firms (but not the Lines Businesses) were also subject to regulatory errors, some of which may have increased their asset betas[23]. The UK firms would also have been less likely to have lowered their output prices within the regulatory cycle so as to conform more closely with costs (because the regulatory design clearly encouraged the earning of excess profits within the regulatory cycle, subject to the price cap); this too is likely to have increased their asset betas relative to the Lines Businesses. On the other hand, the UK firms were periodically subject to mandatory resetting of their output prices in accordance with their costs, and this is likely to have lowered their asset betas relative to the Lines Businesses.

Taking account of these various factors, my judgement is that the UK firms had higher asset betas than the Lines Businesses. Consequently the asset betas of the Lines Businesses lie between the estimates for the US and UK regulated firms. The former is estimated at .30 and the latter at .10-.20 larger. In view of this I recommend an estimate of .30-.50 for the Lines Businesses. Lines Businesses that operate in a more cost-plus fashion would have asset betas towards the lower end of the scale, and those which were not embedded within private sector firms might be of this type. However, more precision in this area would seem to be impossible to attain. I therefore recommend an estimated asset beta of .40 for all Lines Businesses, with bounds of .30-.50.

In using these foreign firms as comparators, there is a further source of difference in the "regulatory" environments that warrants some comment. This is asset valuation methodology. If output prices are set in accordance with costs, then the choice of asset valuation methodology will affect output prices and therefore the riskiness of the

[23] For example, suppose the market risk premium falls over the revision interval but the regulator fails to recognize this at the review time, through a reduction in the allowed cost of capital. The result will be that the firm's value at the end of the revision interval is larger than anticipated at the beginning of it. This shock originates from a decline in the market risk premium, which is also associated with higher than expected actual market returns. Consequently the market value of the firm at the end of the revision interval is exposed to systematic risk.

entity's cash flows. In respect of the US and UK firms, their output prices are set in accordance with costs, with the US firms subject to Depreciated Historic Cost and the UK firms to inflation adjusted Depreciated Historic Cost. In respect of New Zealand, output prices are not explicitly controlled, but this analysis is predicated upon the implementation of a profit threshold. In accordance with such a threshold, Lines Businesses might have the choice of being assessed against Depreciated Historic Cost or ODV (Commerce Commission, 2002b), and the choice could be expected to accord with the basis on which the particular Lines Business sets its prices. Purely for the purposes of assessing the impact of these valuation methodology differences upon betas, it is assumed here that the Lines Businesses are subject to price control, using the asset valuation methodology they elect to be assessed against.

In respect of ODV, this methodology is essentially optimised depreciated replacement cost. Both the act of optimising and the act of using replacement rather than historic cost introduces risks to the firm. However the act of optimisation would inject only industry specific risk at most, i.e., this would not be a market risk. Accordingly the asset beta of the firm would be unaffected. In respect of replacement cost versus historic cost, Lally (2002c) examines this issue and concludes that the use of replacement cost would tend to reduce beta (providing that the CAPM was framed in nominal rather than real terms, which is conventional). The intuition is that the shocks to replacement costs arise from CPI inflation and asset specific inflation. The latter does not affect the asset beta because it is industry specific[24]. So, in using replacement rather than historic cost, the only source of additional systematic risk is CPI inflation. Higher CPI inflation raises replacement costs, and therefore the present value of the entity's future cash flows, whilst being associated with low stock market returns (Fama and Schwert, 1977; Fama, 1981; Chen, Roll and Ross, 1986). Consequently, the firm's rate of return would be negatively correlated with stock market returns[25]. This implies that the firm's nominal returns are negatively

[24] For this reason, the New Zealand and UK firms are similar.

[25] This presumes that, as a result of a rise in the replacement cost of the firm's assets, it raises it revenues to reflect the higher replacement cost, and does not net off the revaluation gain. If the latter is done then the use of replacement cost would not lower the firm's beta relative to the use of depreciated historic cost.

correlated with nominal stock market return[26]. By contrast with the New Zealand firms subject to ODV, the US electricity firms suggested as comparators for them have their prices set in accordance with historic cost valuation. Thus the New Zealand firms should face less systematic risk. However the analysis in Lally (2002c) suggests that the scale of the effect is modest. Accordingly, no adjustment is warranted.

Having suggested estimates for the asset betas of the Lines Businesses, it is useful to compare the conclusions reached here with those reached by the Commission in its Airfields Report (Commerce Commission, 2002a). In respect of their asset betas, the three obvious points of difference lie in the nature of the products, their pricing structure, and the "regulatory" environments. In respect of the nature of the product, the demand for airfield services would seem to involve a higher income elasticity than does the demand for electricity, and this points to a higher asset beta for airfields. In respect of the pricing structures, the charges of the Lines Businesses include a fixed price element whereas the airfield charges do not. This also points to a higher asset beta for airfields. In respect of the last two points, US rate of return regulated electricity firms were used as comparators for airfields, and the recommended increment for the airfields (to account for these two points) was .05. In a subsequent analysis Lally (2002d) provides support for such a modest adjustment.

In respect of regulation, AIAL and CIAL were required to consult with their customers over any changes to their charges, and had informal understandings concerning the frequency with which charges would be reassessed (three years). In respect of WIAL, there was also a requirement to consult with customers over changes to charges. Furthermore, and unlike the other two airfields, this led to a formal specification for the resetting of prices. Subject to that, its charges were fixed for a five year term. As a result the airfields were judged to face regulatory regimes that lay between those for the US and UK regulated electricity firms, and accordingly the asset betas of the airfields were judged to lie between those of the US and UK

[26] Such reasoning is consistent with a positive risk premium in long-term interest rates, i.e., higher than expected CPI inflation lowers the value of long-term bonds and therefore returns on long-term bonds are positively correlated with stock returns. This is positive systematic risk. Consequently, long-term interest rates will embody a positive risk premium.

electricity firms. By contrast the Lines Businesses face no explicit controls. Nevertheless, and for different reasons, they have been judged to have asset betas that are also bounded by those of the US and UK electricity firms.

The final step here is to examine how the Lines Businesses perceive their own asset betas. They are required to calculate the economic value of parts of their business, and some of them have disclosed the asset beta estimates used in doing so. In particular, Transpower uses a figure of 0.25, Buller Electricity uses 0.35, Counties Power uses 0.40, Dunedin Electricity uses 0.30–0.40, United Networks uses 0.40, and WEL Network's uses 0.40. So, the figures range from 0.25 to 0.40. These results are modestly lower than the 0.30-0.50 range suggested here.

In summary, in the presence of a profit threshold, I consider that the asset betas for the Lines Businesses would be bounded by those of US and UK regulated electricity firms. This implies values ranging from .30 to .50. Lines Businesses that operate in a more cost-plus fashion would have asset betas towards the lower end of the scale, and those which are not embedded within private sector firms might be of this type. However, more precision in this area would seem to be impossible to attain. I therefore recommend an estimated asset beta of .40 for all Lines Businesses, with bounds of .30-.50.

A number of submissions by or on behalf of the Lines Businesses have argued for a higher range on this parameter. Emanuel (2003a) argues for .40 to .60, with the latter approximating his estimate of the asset beta for the UK firms (.58), and drawn from the Alexander et al study (1995). Interestingly this is also the source for my upper bound of .50. The difference in outcomes is attributable to my undertakings two adjustments to the Alexander et al figure. First, I invoke the Alexander et al estimates for both UK and US firms to establish the differential between these two sets (up to .20), and then combine this differential with a wider range of estimates for the US firms (.30) to produce a current estimate for both sets. Second, in generating all of these estimates from foreign markets, I correct for market leverage differences between these foreign markets and New Zealand. Emanuel (ibid) does not undertake either of these additional steps.

Dunedin Electricity (2003) favours a point estimate of .50, on the grounds that the combination of both price and profit thresholds is riskier than either regime in isolation. Given this argument, and their apparent acceptance of the asset betas of .30 and .50 for profit and price cap regimes, I am surprised that their point estimate is not *larger* than .50. This aside, the argument suffers from two difficulties. First, it treats price and profit thresholds as equivalent to price and profit caps, which they are not. For example, a price cap simply precludes a price rise in excess of it whereas a price threshold is simply a level whose breach *might* lead to a price cap being established, depending upon the explanation for the breach. For example, if the price (but not the profit) cap is breached due to an increase in the uncontrollable costs of a Lines Business, then a price cap might not be imposed. Secondly, even if it were true that the combined thresholds equated to that of combined price and profit caps, the effect of the two caps would be to *lower* risk relative to only a price cap because the excess profits that could arise under a price cap would be precluded in the presence of both caps. Accordingly, the asset beta would be lower, not larger. Of course, the presence of both caps rather than merely a price cap would also lower the expected cash flows of the business, but this is not a beta issue.

LECG (2003) also favours a point estimate of .50. They argue that the threat of a price cap arising from price and profit thresholds will drive Lines Businesses to act in the same fashion as they would if a price cap were actually in place. This then implies an asset beta matching that for a price capped business (.50). However a business subject to only a price cap is free to earn excess profits so long as they do not breach the price cap. By contrast, a Lines Business subject to a profit as well as a price threshold may be at least partly constrained from earning those excess profits. Accordingly, the Lines Businesses faces less risk than a business that was only price capped.

PwC (2003a) also favours a point estimate of .50. In support of this they reiterate the arguments raised by Dunedin Electricity and LECG. In addition they argue that the regulatory uncertainty facing the Lines Businesses is at least as great as that facing the UK firms, and this argues for an asset beta of at least .50. However they acknowledge that only systematic regulatory risk matters here and offer one example of this: volume increases will translate into higher profits whilst volume decreases translate into lower profits because the price threshold restrains a price rise in the latter case. This is exactly the situation facing a price capped firm, and points to an asset beta of .50. However, as noted earlier, a price threshold is less restrictive than a price cap and this implies less risk for the Lines Businesses. Thus the only specific example offered by PwC in support of their argument actually supports a lower asset beta.

NECG (2003b) also favours a point estimate of .50, and they offer two arguments. The first is that presented by LECG (2003), and dealt with above. The second is that their point estimate is consistent with the estimate of PowerCo asset beta presented here on page 25. However it is interesting to note that they make no mention of the other two entries in that table, which involve considerably lower values. Furthermore, as noted earlier, the estimated betas from even three companies are too few to place much reliance on. The results from one company, particularly when it selected to support a conclusion, warrants even less attention.

On the other side of the industry, MEUG (2003) argues for a point estimate of .35 rather than .40. This arises from the same process that I observe except that they argue for an estimate on US electric utilities of .20-.30 rather than .30. When coupled with my recommendation of an increment of .10-.20 for the UK firms, this yields a range across the two sets of firms of .20-.50, with a midpoint of .35. However they offer no evidence in support of their band of .20-.30 for the US firms.

Finally, Transpower (2003) argues for estimates of asset betas that are specific to individual Lines Businesses. However, as indicated earlier, it does not seem to be possible to assign different estimates across the Lines Businesses, even if there are grounds for supposing that a particular company has a lower value than another. The primary source of evidence in this area must be estimates drawn from large sets of listed electricity distributors (such as the US and UK firms), and the resulting estimates do not lend themselves to differentiating amongst the Lines Businesses

In summary, I do not consider that the arguments in these submissions support an asset beta outside the range .30-.50, or a point estimate other than .40.

2.5 Leverage

The WACC of a firm is affected by its leverage. The issue here is whether actual firm level leverage should be recognised in determining WACC, or whether some assessment of optimal leverage should be invoked. If actual costs are utilised in assessing excess profits, then consistency demands that actual firm level leverage should be invoked (in so far as it can be observed). By contrast, if efficient costs are utilised in assessing excess profits, then consistency demands the use of optimal leverage.

In respect of using efficient costs, and therefore optimal leverage, the optimum level could be assessed by examining the average level amongst relevant firms. Recent leverage values for firms within the industry are admissible, and the data shown on page 25 indicates an average of .45. However, data on only three firms is available here, and therefore leverage levels for similar industries should also be considered, i.e., monopolistic industries with stable cash flows. An appropriate comparator is airfields, and a figure of .25 was employed in the Airfields Report (Commerce Commission, 2002a). By way of comparison, the average leverage of New Zealand firms is around .20 (Ernst and Young, 2000). In view of all this, I recommend a leverage level of .40. Fortunately one does not need to assess this level with great precision because the effect of such variations in leverage (along with the associated debt premium) on WACC is modest when the tax-adjusted version of the CAPM is employed (see Lally, 1998b).

In respect of using the actual costs of a firm, and therefore its actual leverage, the range of admissible values is considerably larger than that just discussed, ranging from zero to about .60. The alternative is to simply use the optimal level assessed above. The effect of using actual firm level leverage rather than the optimal level assessed is then a variation of up to .40. This range, when coupled with the associated range in the debt premium, would affect WACC by less than .30%[27]. Whether this is a sufficiently large figure to be troubled with is debatable. My recommendation is to use the figure of .40 in the initial investigation of excess profits, and to consider using

[27] This figure is derived in the following section.

actual figures for individual firms in any subsequent investigation (and then only if actual rather than efficient costs are being employed).

A number of submissions argue for company specific estimates of leverage (Emanuel, 2003a; Transpower, 2003). However the relevant leverage is market value leverage and this is currently observable for only two of the Lines Businesses[28]. Furthermore, I have suggested an industry leverage figure only for the initial investigation, with any subsequent inquiries into specific firms to reflect firm specific leverage (in so far as actual costs are considered and market leverage can be observed for that firm). In addition, NECG (2003b) argues for leverage of .50, presumably for all Lines Businesses. However no evidence is offered in support of this figure.

Finally, MEUG (2003) argue for an optimal leverage of zero, on the grounds that there is no tax benefit from debt. This claim is entirely consistent with the model in equations (1)…(5). However there are other arguments in favour of debt, and the fact that most firms have significant debt suggests that the net effect is advantageous. Accordingly, I favour an optimal debt level based on observation of firms' leverage.

2.6 The Debt Premium

This is the margin by which the cost of debt exceeds the risk free rate, and was set at .01 for the airfields. Such a rate is towards the low end of the range for this parameter[29], in recognition of leverage levels that were not especially high and operating risk that almost precluded bankruptcy[30]. The latter in turn sprung from the essential nature of the product and the monopolistic nature of the industry. In respect of the Lines Businesses, they are similar to the airfields in the latter two senses, but the suggested leverage of .40 for the Lines Businesses is larger than that assumed for the airfields. Accordingly, the debt margin is expected to be larger than .01.

[28] PowerCo is one of these two companies, and Emanuel is submitting in support of them. Nevertheless, his proposal for firm specific allowances for leverage could not be applied to all of the Lines Businesses.

[29] The range spanning most companies is .01-.02 (Lally, 2000, p 6).

[30] The leverage underlying this premium was AIAL's leverage of .25, slightly higher than the market average of .20.

Some of the Lines Businesses report debt premiums in their latest ODV valuations or EVA reports, and they range from .005 to .015 along with leverages of about .60 in all cases[31]. The best information in this area is current market yields from traded bonds along with current market value leverage. Amongst the Lines Businesses only PowerCo can offer both types of information, although the bond trades are infrequent. Recent trades (March 20, 2003) reveal a premium of about .012 along with market leverage of about .50[32]. Transpower also offers information on current market yields but not market value leverage, and recent trades (March 20, 2003) reveal a premium of about .005. Vector also offers information on current market yields but not market value leverage, and recent trades (March 20, 2003) also reveal a premium of about .012. So, having recommended an optimal leverage figure of .40 for the Lines Businesses, to be used in the initial investigation of excess profits and also in subsequent investigations whenever efficient costs are invoked, an associated debt premium of .012 is recommended. This essentially reflects the data from PowerCo and Vector, and is likely to be too high for Transpower.

In respect of subsequent investigations, in which actual firm level costs are invoked, actual leverage might be employed and this could vary significantly from the figure of .40 noted above. In this event the actual debt premium would be required. Since the figures required will depend upon leverage levels that cannot yet be specified, no such figures will be offered. However, the maximum adjustment can be suggested. This involves a leverage level of zero or .60 rather than the .40 otherwise used. In respect of leverage of .60, the debt premium would rise, from .012 to .015 at most[33]. With the WACC governed by equations (1)….(5), WACC can be expressed as

$$WACC = k_u + p(1-.33)L \qquad (6)$$

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[31] The figures are .005 for United Networks, .01 for Counties Power and United Networks, and .0125 for Transpower. The leverage figures appear to be book values and these can diverge substantially from market values. Of these companies, only United was listed at the time and therefore is amenable to calculation of its market value leverage (being 42% as of 31.3.2002).

[32] The premium is calculated by comparing the yield on a PowerCo bond with the yield on government stock with the same maturity date. If matching maturity dates cannot be found then interpolation over the range of government bonds is invoked. Leverage is calculated from the company's current market capitalisation and the book value of its debt at the time of the latest Annual Report.

[33] This is consistent with the information noted above for PowerCo.

where k_u is the unlevered cost of equity. The only effect of changes in leverage and the debt premium lies in the last term here. With leverage at .40, and the debt premium at .012, this term is .003. With leverage at .60, and the debt premium at .015, this term rises to .006. With leverage of zero, this term falls to zero. In either case, the difference is .003, i.e., .30%.

A number of submissions have argued for a higher debt risk premium. Dunedin Electricity (2003) argues for a margin of .014-.019 but offers no information about specific Lines Businesses in support of this. Interestingly, they also argue for using current market yields from PowerCo and Vector, on the grounds of being the only Lines Businesses offering such information. In fact Transpower also offers such information, and the current margins on all three companies range from .005 to .012 (as noted above). PwC (2003a) argues for a margin of .015 (on leverage of 30%), but again offers no information about specific Lines Businesses in support of this. LECG (2003) argues for a margin of .015 (on leverage of 50%), and suggest that this is consistent with the market data disclosed here. In fact the market data ranges from .005 to .012. NECG (2003b) argue for a premium of .014 (on leverage of 50%), but offer no data in support of this.

Finally, NECG (2003a, 2003b) argues for adding an allowance for the costs of public debt issues, the above examples being of this type. In their first submission (NECG, 2003a), they argue for .005. In support of this figure they invoke an issue cost of at least .025 (from a US study: Lee et al, 1996, Table 1), and then convert this to annual equivalent of at least .005, assuming a ten year bond. These costs could be recognised through WACC or the operating cash flows. However, I consider that allowance for them through WACC is superior, because (like the depreciation on fixed assets) it allocates the costs to all periods rather than concentrating them in the periods in which they are paid. Nevertheless, NECG's (2003a) figures are questionable. First, for an issue cost of .025, the annual equivalent on a ten year bond would be .0036, not .005 (using a discount rate of .070). Furthermore, the Lee et al figure of .025 is for companies in general rather than utilities, and the same study (ibid, Table 2) records considerably lower figures for utilities. In particular, Table 2 suggests an average issue cost of about .013 (by averaging over issues of at least $40m). Using their ten year bond term, the equivalent annual figure would be about .002[34]. Even this figure may be too high as it reflects the institutional and legal environment of the US rather than New Zealand. Interestingly, NECG (2003b) suggests this very figure of .002 in their subsequent cross submission. Invoking equation (6) above, the effect upon WACC of adding .002 to the debt premium would be only .0005, i.e., .05%. So, whilst I am sympathetic in principle to an allowance here, the uncertainties about the appropriate size of the adjustment, and the trivial effect of the figure upon WACC, argues for making no such allowance. Lest it be suggested that a series of such judgements might exert a more substantial downward bias on WACC, there are contrary instances here. For example, the debt risk premium suggested above of .012 is clearly too high for at least one of the Lines Businesses (Transpower).

In summary I do not consider that the arguments in these submissions support a debt margin in excess of the .012 recommended here.

2.7 Allowance for Asymmetric Risks

Asymmetric risks comprise the risks of assets being stranded, of assets being optimised out by a regulator, and of miscellaneous exposures to such events as adverse (and uninsurable) weather conditions. Stranding is the circumstance in which a demand shortfall prevents a business from recovering certain costs from either the intended or other customers. By contrast, optimisation is an accounting device that may be employed or required by regulators, to discourage over-investment, and under which certain assets are excluded from the rate base in a price control situation or excluded from the admissible costs in an investigation of excess profits.

In respect of these risks, and in the context of setting a profit threshold and subsequently investigating whether excess profits have arisen, the appropriate actions by the Commission are now considered. In respect of optimisation risk, this would only arise if the business were assessed against an ODV asset valuation basis, and this

[34] NECG (2003a) argues that use of a five year term for the risk free rate implies that bonds must also be of the same term. However the reasoning in Lally (2002a) that leads to setting the risk free rate term neither assumes that firms will borrow for the same term nor drives them to do so. In particular the issue of interest rate risk could be dealt with by coupling a ten year bond with a five year swap contract.

option was proposed by the Commission in its draft decisions (Commerce Commission, 2002b). In the event of assets being optimised out by the Commission, the resulting profit would involve a smaller depreciation cost and a smaller base for determining its cost of capital. If this occurred, the business would have to lower its output price so as to avoid a situation of excess profits. Some form of ex-ante protection would then be indicated, and this could take the form of a “margin on WACC”. If the actual level of optimisations matches that anticipated, then the two effects offset, and the firm need not alter its prices; if the actual level is higher, then the firm must reduce its prices or else excess profits will be observed and they should be judged as such. This paper does not attempt to assess the size of this compensatory margin. In its draft decisions (Commerce Commission, 2002b), the Commission proposed a “margin on WACC” for those businesses that elected to be assessed against an ODV rather than a DHC asset valuation base.

In respect of the miscellaneous risks such as adverse weather conditions, the situation is as follows. The business deals with the matter as it chooses, either by raising prices ex-ante or ex-post to protect itself. If it raises prices ex-post, the increased revenues will offset the increased costs and there is no resulting effect upon profits. By contrast, if the business raises prices ex-ante, then during the period of the profit assessment, the business might experience a low incidence of these adverse events and consequently its profits will appear to be excessive. In the same way, an insurance company that did not experience any large claims during a period would appear to be charging excessive premiums. A possible response to this problem is to assess performance over a sufficiently long period that extreme events are represented to an extent that reflects their expected incidence. However, by virtue of being extreme, this will always be difficult to attain. Thus, if excessive profits appear to have been made, one must form a judgement as to whether this can be explained by extreme events that are underrepresented. This requires some judgement about an appropriate ex-ante revenue increment to accommodate these costs, along with identification of any costs incurred that are of this type. If the difference can explain the observed excess profits, then there is no cause for concern. This paper does not attempt any assessment in this area.

Finally, in respect of stranding, there are essentially two possible regulatory approaches. The first is similar to that of optimisation, in which stranded assets are removed from the cost base used to determine excess profits. As with optimisation this argues for some form of ex-ante compensation, such as a "margin on WACC". The alternative approach is not to remove such assets from the cost base used to determine excess profits, in which case no ex-ante compensation is required. In its draft decisions (Commerce Commission, 2002b), the Commission proposed no allowance for stranding. Regardless of which approach is adopted by the Commission, the business must still protect itself against a real economic risk, and it must do so by increasing prices ex-ante. This gives rise to the issues discussed in the previous paragraph. However the issue is unlikely to be substantial in the present context because stranding is most likely to occur for dedicated assets (supplying individual industrial consumers, which are at risk of closure). In these cases, Lines Businesses are likely to have entered into bilateral contracts to manage such risks.

2.8 Form of Ownership

In applying the CAPM for estimating the WACC of an entity, the usual presumption is that the entity is a private sector company. However, the ownership of the companies in which the Lines Businesses are embedded include central government (Transpower), community trusts, consumer trusts and councils. The implications of this for the asset beta have already been discussed, and it has been suggested that quantification is impossible. There are two further implications.

The first of these issues concerns tradability. The ultimate ownership claims over Transpower arise from being a New Zealand taxpayer, those over the Council-owned companies arise from being a local ratepayer, and those in respect of the consumer trusts arise from the mere purchase of electricity in some geographical regions. In respect of the companies that are owned by community trusts, the situation is even less clear. None of these "shareholdings" can be traded. Stapleton and Subrahmanyam (1978) consider this issue in the context of public sector entities, but their conclusions extend to non-tradable shareholdings in general. They show that if the allocation of claims on public sector entities differs from that arising if trading were possible, then some investors will prefer (in a utility sense) an increase, and others a decrease, in the level of investment by such entities, relative to the level if all entities were private. Thus no discount rate, market based or otherwise, could determine the optimal level of investment by public sector entities[35]. However they demonstrate that decreased investment by such entities is optimal in the Hicks (1940) and Kaldor (1939) sense, i.e. if the investors preferring the reduction could make compensating payments to the others, then the first such group would still be better off in utility terms. Thus a lower level of investment, and hence a higher discount rate, is implied relative to the circumstance in which all entities were private. This is to compensate for risks that cannot be efficiently allocated through trading. However quantification does not seem to be possible.

The second issue concerns personal taxation. The returns to investors from private, but not public, sector projects attract personal tax, and this drives up private sector discount rates. Thus private sector discount rates will be too high for the public sector (Arrow, 1982). However, in respect of equity returns, the effect of dividend imputation and modest effective capital gains tax is to generate only a low rate of tax. Thus the issue is slight here. By contrast interest is non-trivially taxed, and the interest rate is presumably then driven upwards to compensate. Since tax of any sort is zero-sum to the public sector, this points to use of a cost of debt that would prevail in the absence of personal tax on it, and this could be approximated by the market rate net of the personal tax paid on it. This would lead to a lower WACC for the public sector. If output prices in the public sector were set in light of this thinking then a matching reduction in the WACC might be appropriate. However there is no evidence for this. In fact, as evidenced by the imposition of corporate taxation upon State-Owned Enterprises, the intention of government has been that they mirror private sector companies. Assuming then that they adopt the same pricing policy, they should face the same test for excess profits. So, the same WACC model should be applied. Thus the public sector discount rate should not be lowered to reflect this personal tax issue.

[35] As the discount rate rises, the set of projects that have a positive NPV contracts. So, those investors favouring an increase in investment will consider that a lower discount rate is appropriate, whereas those favouring a reduction in investment will consider that a higher discount rate is appropriate. Thus, there is no discount rate that determines the optimal set of investments.

Brookfields (2003) suggest that there is a further ownership issue with WACC implications. In particular, they argue that the shareholders of consumer trusts are indifferent between dividends and lower prices whereas the shareholders of other Lines Businesses are concerned exclusively with dividends. However they do not further explain how this point bears on the estimation of WACC. To say that the shareholders of consumer trusts are indifferent between dividends and lower prices is equivalent to saying that the dividends received by these shareholders can be direct or indirect. However the precise form that dividends can take does not affect WACC, unless there are personal tax implications, and this does not appear to be the case.

In summary then, the form of ownership should not affect the WACC model employed.

2.9 WACC Estimates

Drawing upon the above estimates for various parameters, WACC estimates can now be offered, using equations (1)…(5). The market risk premium ϕ is assessed at .07, with bounds of .06-.08 to reflect uncertainty about the true value of the parameter. Regarding the risk free rate R_f, the conceptually preferred rate is the three year one, set at the time of implementing the profit threshold and then reset in three years, although there are pragmatic advantages to simply using the rate corresponding to the period for which excess profits are assessed. The three and five year rates (March 2003 average) are both .055[36]. The appropriate asset betas β_a for the Lines Businesses are assessed at .30-.50, with variation according to how closely they conform to a cost-plus policy. However, more precision in this area would seem to be impossible to attain. I therefore recommend an asset beta of .40 for all Lines Businesses, with bounds of .30-.50. Finally, in respect of leverage L and the associated debt premium p, I recommend values of .40 and .012 respectively for all Lines Businesses in both the initial investigation and any subsequent investigation in which efficient costs are invoked. Should a subsequent investigation invoke the actual costs of a firm, then the firm's actual leverage and associated debt premium could be invoked.

[36] The five year rate is the average of the five year yields reported by the Reserve Bank over the month of March 2003, which is then converted to a compounded annualised figure of .055. The three year rate is calculated from the Reserve Bank data for two and five year bonds, with interpolation.

These parameter values are now translated into WACC estimates. In particular the lower bound, point estimate and upper bound are as follows.

ϕ	R_f	β_a	L	p	k_e	$WACC$
.06	.055	.30	.40	.012	.067	.058
.07	.055	.40	.40	.012	.084	.068
.08	.055	.50	.40	.012	.104	.080

The presentation of a band gives some flexibility in estimating excess profits. In particular, excess profits could be estimated under all three estimates and a judgement then made as to which of the resulting estimates should be given greatest weight.

2.10 Comparison with Australian Regulatory Judgements

Having offered estimates of WACC for the Lines Businesses in New Zealand (under a profit threshold), based on various parameter estimates and a set of formulas, these are now compared with recent WACC judgements by Australian regulators (most particularly the ACCC) in respect of electricity distributors. As indicated in ACCC (1999, 2001), there is agreement upon equations (1) and (2). However, equation (3) is replaced by an alternative model (Officer, 1994), which essentially differs from (3) in assuming that capital gains are taxed equally with interest. Consistent with this, the gearing formula (5) also differs.

In respect of the market risk premium, the ACCC (2001) favours a value of .06 compared to the estimate of .07 recommended here. However the definitions of these two parameters differ[37], as do the taxation and risk environments. In respect of different definitions of the market risk premium, an estimate of .06 for the market risk

[37] The Australian regulators favour use of the Officer (1994) version of the CAPM, which differs from the model recommended here (and most widely used in New Zealand). The difference is that the former model assumes that capital gains are taxed at the ordinary rate whereas the latter model assumes that they are not taxed. Neither assumption is perfectly accurate. However, capital gains are more heavily taxed in Australia than in New Zealand, and this could explain the different choice of models in the two markets.

premium in the ACCC's model would translate into an estimate of about .055 for the standard CAPM (see Lally, 2000, p. 7). With a risk free rate of around .060, the implied value for the market risk premium in equation (4) would then be .075, and this is very similar to the figure of .070 recommended for New Zealand. In respect of taxation differences, Australian equities are more heavily taxed relative to bonds than is the case in New Zealand, due to a lower level of exemptions from capital gains in Australia. This has the effect of driving up the market risk premium in Australia. Thus the figure of .075 would have to be reduced for proper comparison with the New Zealand figure of .070. In respect of risk differences, the variability of equity returns in Australia appears to be less than in New Zealand (see Lally, 2000, p. 20). This has the effect of lowering the market risk premium in Australia, and therefore the figure of .075 would have to be raised for proper comparison with the New Zealand figure of .070. All of this suggests that the figure of .060 in the ACCC's model is consistent with the figure of .070 recommended here for the market risk premium in equation (4).

In respect of the risk free rate, the ACCC's (2001) concern is with setting a price cap rather than assessing excess profits, and it favours a risk free rate equal to the length of the regulatory cycle. This is to ensure that the present value of the firm's future cash flows match its initial investment (see Lally, 2002a, for further detail). This is consistent with that recommended in section 5 of this paper, in which price caps are examined.

Regarding the asset beta, the Office of the Regulator General (2000, p 282) has recently prescribed a value for Victorian electricity distributors, and summarised the earlier conclusions of other Australian regulators including the ACCC. They cite values from these other regulators ranging from 0.31 to 0.49 and conclude with a value of .40. These results are those that would have arisen if the debt beta were zero, and therefore are compatible with the gearing equation (4) used in this paper[38]. However these numbers are offered in the context of setting price caps for five years,

[38] The debt beta reflects the systematic risk of a firm's bonds. Some Australian regulators have acknowledged debt betas in their gearing formulas relating a firm's equity beta to its asset beta. The asset betas arising from such a formula must then be corrected for the presence of the debt beta before the results can be compared to those invoked in this paper. The eventual effect upon equity betas of recognising that debt betas are not zero is generally slight, and there are considerable difficulties in estimating these debt betas (Lally, 1999, p 32).

and therefore are not directly comparable with the estimate of .40 offered above in this paper for the purpose of assessing past excess profits. The issue of price caps is discussed in section 5 of this paper, and concludes with an estimate of .40-.50 for the asset beta when setting caps for five years. This range of .40-.50 can then be compared with the Australian estimates of 0.31 to 0.49. Thus the Australian numbers are only moderately lower.

Finally, in respect of leverage and the debt premium, the ACCC (2001) favours figures of .60 and .012 respectively (the leverage figure is a judgement about the optimal level, and the debt premium then follows from it). The first of these numbers differs from the .40 suggested in this paper. However, following the analysis in section 2.6, the effect of using the Australian leverage value would raise the WACC by only .16%.

In summary, Australian regulators favour parameter values that are similar to those suggested here. The only obvious difference lies in their preference for a different version of the CAPM to that recommended here.

3. Employing the WACC to Evaluate Excess Profits

3.1 Evaluating Excess Profits in Dollar Terms

This section examines how a WACC should be incorporated into an evaluation of excess profits. The term excess profits must be defined, and we do so in dollar terms in this section. Viewed ex-ante, a business could be said to be making excess profits if the Net Present Value of future cash flows over the life of its existing projects was positive. However, such an ex-ante definition is not useful as a test because it is too subjective. This suggests that its ex-post counterpart be used, i.e., discount the actual cash flows earned by the business back to the initiation date of the existing projects (this is called the ex-post NPV)[39]. Even this is unworkable for a review period that is less than the life of the projects, because an NPV (ex-ante or ex-post) can only be calculated from cash flows over the entire life of a project. Thus we require a

[39] The ex-post NPV must use the same discount rate (WACC) as the ex-ante NPV, to ensure that the expectation of the ex-post NPV is equal to the ex-ante NPV, i.e., the ex-post calculation is unbiased.

measure of excess profits that can be applied to any review period, and which is equivalent to the ex-post NPV over the life of the business' existing projects.

The measure implied by the ex-post NPV test is that of "Compounded Excess Earnings". For year t within the review period, "Excess Earnings" is

$$Excess\,Earnings_t = CF_t + REV_t - DEP_t - kB_{t-1} \tag{7}$$

where CF is the operating cash flow (this excludes capital expenditures/disposals), REV is revaluations, DEP is depreciation, k is the WACC and B_{t-1} is the book value of assets at the beginning of year t. These Excess Earnings are each compounded to the end of the review period using the WACC, and summed. When this sum is computed over a review period equal to the life of the business, it is equivalent to the ex-post NPV, in that the former is simply equal to the latter compounded over the life of the business. The proof of this is in Appendix 1. However, unlike the ex-post NPV, Compounded Excess Earnings can be calculated for any review period.

An example is as follows. For a business with a life of two years, operating cash flows (CF), depreciation (DEP), capital expenditures (CAP), and the cost of capital (k) for each year, are as follows.

	Year 1	Year 2
CF	\$10m	\$12m
DEP	\$6m	\$7m
CAP	\$3m	\$1m
k	.10	.09

In addition, the initial book value of the assets is B_0 = \$9m. In conjunction with the DEP and CAP data above, this implies book values for the assets in one and two years of B_1 = \$6m and B_2 = 0. In this example, asset revaluations are ignored so as to simplify the example[40]. In addition, capital expenditures are assumed to occur at the end of a year, for the same reason[41]. The ex-post NPV is then

$$Ex-Post\ NPV = \frac{\$10m - \$3m}{1.10} + \frac{\$12m - \$1m}{(1.10)(1.09)} - \$9m = \$6.5m$$

Compounded forwards for two years, this is

$$\$6.5m(1.10)(1.09) = \$7.8m$$

Since this is positive then it is evidence of excessive profits. Following equation (7), the "Excess Earnings" for each of the two years are then as follows.

$$Excess\ Earnings_1 = \$10m - \$6m - (.10)\$9m = \$3.1m$$

$$Excess\ Earnings_2 = \$12m - \$7m - (.09)\$6m = \$4.5m$$

The compounded sum of these Excess Earnings is then

$$Compounded\ Excess\ Earnings = \$3.1m(1.09) + \$4.5m = \$7.8m$$

and this matches the ex-post NPV. "Excess Earnings" can be calculated for any period, and is therefore suitable as a test for excess profits. For example, at the end of the first year, the "Compounded Excess Earnings" would simply be the "Excess Earnings" for the first year, of \$3.1m.

This process of calculating "Compounded Excess Earnings" was invoked in the Airfields Report (most particularly in Lally, 2001c), except that the rate used there for compounding the "Excess Earnings" was the risk free rate rather than the cost of

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[40] If revaluations were acknowledged the depreciation term *DEP* would simply be replaced by depreciation less revaluations.

[41] If capital expenditures occur during a year then the cost of capital term in Excess Earnings should be raised in so far as this is material. By contrast, disposals and revaluations that occur during a year should be treated as if they occurred at the end of the year. Appendix 2 discusses this issue in detail.

capital. The use of the risk free rate seems reasonable in view of the fact that the "Excess Earnings" numbers are actual outcomes rather than expectations. However the analysis here and in Appendix 1 shows that the correct rate for compounding is the WACC.

Some submissions nevertheless argue for compounding at the risk free rate rather than WACC. PwC (2003c) argues for doing so on the grounds that excess profits can only be invested in risk free assets or used to pay down debt. However, the reasoning in support of compounding excess profits at WACC can be decomposed into the following steps. First, an ex-ante NPV must use the WACC for discounting. Second, an ex-post NPV must use the same discount rate (WACC) to ensure that the expectation of the ex-post NPV equals the ex-ante NPV. Third, compounding excess profits at WACC is mathematically equivalent to an ex-post NPV calculated using WACC. Thus, if PwC (2003c) disagrees with the third step, they are implicitly disagreeing with the first step. In particular, they must be suggesting that the ex-ante NPV of a regulated business comprises two parts – the cash flows consistent with the regulations (discounted at WACC), and the excess cash flows (discounted at the risk free rate). However these excess cash flows are not certain ex-ante, and therefore do not warrant a discount rate equal to the risk free rate. Once they arise, they may be invested into risk free assets (as might any cash flows), but the way in which cash flows are subsequently invested is immaterial to the discounting process. The discounting process simply reflects the risk surrounding the generation of the cash flows, not their subsequent treatment.

In addition, Vector (2003) also argues for compounding excess profits at the risk free rate rather than WACC, because the amounts are certain at the end of each year. This rationale could equally be applied to the actual cash flows from any risky project. As indicated above, this practice would generate an ex-post NPV whose expectation diverged from that of the ex-ante NPV, i.e., the process would be biased.

3.2 Evaluating Excess Profits in Rate of Return Terms

An alternative approach to the evaluation of excess profits in dollar terms is to do so in rate of return terms. A number of possibilities are apparent here. For example, one could measure the accounting rate of return for each year and compare it with the WACC; excess profits would be signalled when the former exceeded the latter. However, as discussed in Lally (2001c), these accounting rates of return cannot be aggregated or even averaged over a number of years, and this retards their usefulness.

A second possibility is the internal rate of return (IRR). The usual ex-post sense in which this term is used is in respect of projects, and can only be determined when the project is completed or sold. In this event the IRR is the rate of return that discounts the actual cash flows received from the project (inclusive of the sale price if it is sold) back to the initial expenditure. Simon Terry and Associates (2000), and Bertram (2002), have applied this concept to businesses in a number of studies[42]. If the IRR is greater (less) than the cost of capital, then profits are judged to be excessive (inadequate). In applying the idea, the initial investment used was the book value at which the enterprises were corporatised (although this is not uncontroversial). In some cases, the phenomena that are present valued back to this are the operating cash flows (net of capital expenditure) and the sale price. There are two difficulties with the use of the sale price here. First, if the sale price is to be used, then the cash flows should be the dividends and interest paid out to capital suppliers, i.e., in so far as the operating cash flows are not paid out, they are embodied in the subsequent sale price, and therefore double counting occurs. Secondly, the sale price reflects some factors that do not bear on the question of excess profits over the period of study; for example, the sale price may reflect hubris on the part of the buyer, or expectations of excess profits in future years.

An alternative approach explored by them involves present valuing the operating cash flows (net of capital expenditures) and the book value of assets at the end of the period of study. However there is still a difficulty here in that comparison of the IRR over the review period to a WACC presumes that the WACC is constant over all years, and this is generally not true. The most apparent source of variation is in the

[42] Descriptions of the methodology are more detailed in Bertram (2002), and therefore this paper is drawn upon in the subsequent discussion.

risk free rate, and this is quite variable: over the past five years, the two year rate (even averaged over a month) has varied from .046 to .078[43].

To obtain a rate of return concept that is appropriate for measuring excess profits, we return to the previous section in which excess profits over the life of the business were calculated using the ex-post NPV. If the WACC is constant over time, the ex-post NPV is equivalent to calculating the IRR on the business' actual cash flows, and comparing it to the WACC, i.e., if the ex-post NPV is positive (negative) then the IRR will be greater (less) than the WACC. If the WACC is not constant over time then one must express the IRR as the sum of the WACC for a year and a premium p that is treated as constant over all years. If the ex-post NPV is positive (negative), then the premium p will be positive (negative). For a business with a life of n years, and an initial investment of B_0, this premium p solves the following equation

$$B_0 = \frac{CF_1 - CAP_1}{1 + k_1 + p} + ... + \frac{CF_n - CAP_n}{(1 + k_1 + p)(1 + k_2 + p)....(1 + k_n + p)}$$

Like the ex-post NPV, this premium is defined only across the entire life of the business, and therefore is not useful for a review period that is less than the life of the business. However, if one simply treats the book value of the assets at the end of the review period as if it were a cash flow received at that time, and then calculates the premium with respect to these cash flows, the result is a rate of return counterpart to the Compounded Excess Earnings, i.e., if the Compounded Excess Earnings are positive (negative), then the premium p will be positive (negative). The proof of this appears in Appendix 3.

An example is now offered. For a two year review period, operating cash flows, depreciation, capital expenditures, and the cost of capital for each year are as shown below.

[43] Data from the Reserve Bank website.

	Year 1	Year 2
CF	\$10m	\$12m
DEP	\$2m	\$3m
CAP	\$1m	\$5m
k	.10	.09

In addition, the initial investment is B_0 = \$60m. In conjunction with the *DEP* and *CAP* data above, this implies B_1 = \$59m and B_2 = \$61m. The Excess Earnings are then

$$Excess\ Earnings_1 = \$10m - \$2m - (.10)\$60m = \$2m$$

$$Excess\ Earnings_2 = \$12m - \$3m - (.09)\$59m = \$3.69m$$

The compounded sum of these Excess Earnings is

$$Compounded\ Excess\ Earnings = \$2m(1.09) + \$3.69m = \$5.87m$$

Turning now to the rate of return analysis, the premium p is the solution to the following equation.

$$\$60m = \frac{\$10m - \$1m}{1.10 + p} + \frac{\$12m - \$5m + \$61m}{(1.10 + p)(1.09 + p)}$$

The solution is $p = .047$. So, the excess profits in dollar terms are \$5.87m and in rate of return terms are .047 per year.

In summary, excess profits over a set of years can be measured in dollar terms or in rate of return terms. The former is the Compounded Excess Earnings and the latter is the IRR premium. The issues here are setting a profit threshold, and examining breaches. Both the rate of return and dollar approaches are useful. The threshold could be defined as Compounded Excess Earnings of zero over the period of study. Equivalently, the threshold could be defined as an IRR premium of zero over the period of study. Thus, a business whose Compounded Excess Earnings were positive over the period of study would breach the threshold. Equivalently, a business whose IRR premium was positive over the period of study would breach the threshold. The use of Compounded Excess Earnings has the advantage of expressing the outcome in dollar terms, and the contributions of individual years to any breach are immediately apparent. The use of an IRR premium has the advantage of expressing the outcome in rate of return terms.

3.3 Revaluations of Land

Lally (2001c) also examines the issue of treating revaluations in the context of measuring Excess Earnings, and reaches quite different conclusions about land and other assets. In respect of land it is argued that revaluations should be incorporated into the measurement of Excess Earnings, regardless of whether the businesses have taken them into account in setting their output prices. Failure to do so implies that excessive profits will not be detected.

This is illustrated as follows, with land being the only asset, and the period of review being the two years following the purchase of the land[44]. The initial expenditure on the land is \$10m, and its market value after two years is expected to be \$15m. In addition the operating costs are expected to be \$3.1m in year 1 and \$3.2m in year 2, the cost of capital is .10 and the tax rate is .33. Suppose that the revenues set by the business fail to incorporate any allowance for revaluations, i.e., for the land's value increasing. These revenues will then comprise the cost of capital, grossed up for tax, and the operating costs, i.e.,

$$E(R_1) = \frac{.10(\$10m)}{1-.33} + \$3.1m = \$4.59m, \qquad E(R_2) = \frac{.10(\$10m)}{1-.33} + \$3.2m = \$4.69m$$

[44] The analysis in this section, and in the following two sections, assesses conceptual points. Consequently it is forward-looking, i.e., expected Excess Earnings and the NPV are calculated. This contrasts with the discussion in sections 3.1 and 3.2, in which the process for calculating Excess Earnings is examined. Accordingly the discussion there was in ex-post terms, i.e., actual Excess Earnings were examined, compounded forwards to the date of the review (and, consistent with this, the ex-post NPV was also examined, again compounded forwards to the date of the review).

The present value of the project is then the present value of the revenues, net of operating costs and tax, and the land value in two years, as follows.

$$V_0 = \frac{\left[\$4.59m - \$3.1m\right](1-.33)}{1.1} + \frac{\left[\$4.69m - \$3.2m\right](1-.33) + \$15m}{(1.1)^2} = \$14.13m$$

Since the initial investment is \$10m, then the *NPV* of the project is \$4.13m, and therefore the expected revenues are too high. Thus, the business' failure to allow for revaluations in setting its output price has lead to excessive revenues. If the measurement of Excess Earnings fails to incorporate revaluations, then expected Excess Earnings will be zero in each year:

$$E(Excess\ Earnings_1) = [\$4.59m - \$3.1m](1-.33) - .10(\$10m) = 0$$

$$E(Excess\ Earnings_2) = [\$4.69m - \$3.2m](1-.33) - .10(\$10m) = 0$$

So, the process would fail to detect the existence of excess profits. The correct course of action would be to include revaluations of \$5m in the measurement of Excess Earnings, and this will reveal the existence of excess profits. It is immaterial when this revaluation is done. So, suppose that a revaluation of \$2.5m is recognised at the end of each of years 1 and 2. Such revaluations are tax-free. So, the expected Excess Earnings will then be as follows:

$$E(Excess\ Earnings_1) = \left[\$4.59m - \$3.1m\right](1-.33) + \$2.5m - .10(\$10m) = \$2.5m$$

$$E(Excess\ Earnings_2) = \left[\$4.69m - \$3.2m\right](1-.33) + \$2.5m - .10(\$12.5m) = \$2.25m$$

The present value of these Excess Earnings equals \$4.13m, which is equal to the NPV of the project. So, by recognizing revaluations in measuring Excess Earnings, the process would generate results that reveal the underlying economic situation of excessive revenues.

It might be thought that revaluations should be irrelevant to the setting of a business' output price, and therefore also in the measurement of Excess Earnings, if the business' operation at the particular site is indefinite. However technological change is inevitable, to the point where any business will eventually be terminated, and the increase in land value is then realised by the business' owners. Furthermore, even if this were not the case, a business' failure to incorporate allowance for revaluations in setting its revenues would ensure that the present value of the business' future cash flows failed to grow over time as rapidly as the land value; this shortfall would eventually drive the business' owners to abandon the operation and sell the land. Upon sale of the land, the business' owners would then realise the increase in land value, and this would imply that they earned more than their cost of capital. So, ironically, the conviction that revaluations should not matter in setting revenues (in the belief that the land will never be sold) will eventually force a sale, and thereby contradict the very premise upon which the policy of ignoring revaluations was founded. Furthermore, if the evaluation of Excess Earnings ignored these revaluations, then it would fail to detect the inevitable result that the business will earn more than its cost of capital.

To illustrate this point, suppose the land's current value is \$10m and is expected to grow at 3% p.a indefinitely. Also, there are no operating costs (purely to simplify the example), the tax rate is .33 and the cost of capital is .10. If the business ignores land revaluations in setting its revenues, it will simply set the revenue for the first year at

$$R_1 = \frac{\$10m(.10)}{1-.33} = \$1.49m$$

and this will not change over time. So, net of tax, the business' cash flow will be \$1m per year indefinitely. At the current moment the present value of these future cash flows is

$$V_0 = \frac{\$1m}{1.10} + \frac{\$1m}{(1.10)^2} + \ldots.. = \frac{\$1m}{.10} = \$10m$$

and this matches the current market value of the land. However, in one year, the present value at that point of the future cash flows will still be \$10m but the land is expected to be worth \$10.3m. In ten years, the present value then of the future cash flows (based on revenues set in accordance with the now historic land cost of \$10m) will still be \$10m but the land will be expected to be worth \$13.4m. So, if the business' owners never deviate from their policy of ignoring revaluations in setting their output price, they will be driven to abandon the operation and sell the land (and thereby realise the increase in value)[45]. Suppose this sale occurs in 10 years, at an expected price of \$13.4m. Then the NPV of their investment will then be

$$NPV = \frac{\$1m}{1.10} + ... + \frac{\$1m + \$13.4m}{(1.10)^{10}} - \$10m = \$2m$$

If the evaluation of Excess Earnings ignores the revaluations, it will be expected to yield Excess Earnings of zero in each year. For example, the result for the first year will be

$$E(Excess\ Earnings_1) = \$1.49m(1-.33) - .10(\$10m) = 0$$

So, such an evaluation will fail to detect the excess profits (i.e., NPV that is positive) that are inevitable, because the land is bound to be sold, and this because of a policy of not incorporating allowance for revaluations into the setting of revenues. By contrast, if the evaluation of Excess Earnings does include the revaluations, it will identify the existence of excess profits. For example, the expected result for the first year is

$$E(Excess\ Earnings_1) = \$1.49m(1-.33) + \$0.3m - .10(\$10m) = \$0.3m$$

If the revenues do provide for land revaluations, then the revenues set for the first year will be

$$R_1 = \frac{\$10m(.10) - \$.3m}{1-.33} = \$1.04m$$

The after-tax figure is \$0.7m. Since the land is expected to grow in value at 3% p.a then these revenues are also expected to grow at 3% p.a. Their present value now is then

[45] Even if the existing owners declined to do so, a corporate raider might recognise the opportunity, buy the business and then liquidate the operation.

$$V_0 = \frac{\$0.7m}{1.10} + \frac{\$0.7m(1.03)}{(1.10)^2} + \frac{\$0.7m(1.03)^2}{(1.10)^3} + ... = \frac{\$0.7m}{.10 - .03} = \$10m$$

This matches the current value of the land. Over time the land value is expected to grow at 3%, as will the present value calculated in the fashion shown in the last equation. So, the business' owners will not be driven to abandon the operation so as to sell the land. An evaluation of Excess Earnings in this situation should be expected to yield a result of zero in each year, and this will only occur if revaluations are recognised in measuring Excess Earnings. For example, the expected result in the first year is

$$E(\textit{Excess Earnings}_1) = \$1.04m(1 - .33) + \$0.3m - .10(\$10m) = 0$$

In summary, regardless of whether a business incorporates revaluations of land into the setting of its revenues, the measurement of Excess Earnings must incorporate them. Failure to do so will lead to the process failing to detect excess profits.

3.4 Revaluation of Depreciating Assets

We now consider assets other than land, i.e., depreciating assets. Whether a business allows for revaluations in setting its prices does not matter here because, over the asset's full life, revaluations are offset by depreciation. For example, an upward revaluation of $1 must induce a subsequent increase in depreciation of $1. Lally (2001c) shows that, regardless of whether revaluations are incorporated into the measurement of Excess Earnings, the present value of these Excess Earnings over the full course of an asset's life matches the NPV of the project. The problem arises with measurement of Excess Earnings conducted part way through the asset's life. To identify excess profits, it is necessary for the treatment of revaluations in that evaluation to match that reflected in the business' pricing policy. Thus, if the business allows for revaluations in setting it's output price (i.e., it lowers the price for positive revaluations and raises it for negative revaluations) then the measurement of Excess Earnings should do likewise; if the business does not allow for them, neither should the measurement of Excess Earnings.

To illustrate this, the above example is used except that the asset is worthless at the end of the second year. So depreciation must be applied. Suppose that the revenues set by the business fail to incorporate any allowance for revaluations. These revenues will then comprise the cost of capital, grossed up for tax, the operating costs, and depreciation. The latter is assumed to be \$5m per year. So, the expected revenues for the two years are as follows.

$$E(R_1) = \frac{.10(\$10m)}{1-.33} + \$3.1m + \$5m = \$9.59m, \quad E(R_2) = \frac{.10(\$5m)}{1-.33} + \$3.2m + \$5m = \$8.95m$$

The present value of the project is then the present value of these revenues, less the operating costs and taxes. The latter is 33% of the taxable income, which equals revenues net of operating costs and tax depreciation. To simplify, the latter is also assumed to be \$5m per year. So, the present value of the project is as follows.

$$V_0 = \frac{\$9.59m - \$3.1m - .33(\$1.49m)}{1.1} + \frac{\$8.95m - \$3.2m - .33(\$.75m)}{(1.1)^2} = \$10m$$

This matches the initial investment of \$10m, and so the *NPV* is zero, i.e., the expected revenues just cover the costs. If the measurement of Excess Earnings also ignores revaluations, it will generate expected Excess Earnings of zero in each year, as follows.

$$E(Excess\ Earnings_1) = \$9.59m - \$3.1m - \$5m - .33[\$1.49m] - .10(\$10m) = 0$$

$$E(Excess\ Earnings_2) = \$8.95m - \$3.2m - \$5m - .33[\$.75m] - .10(\$5m) = 0$$

However, if the process were to incorporate a revaluation of \$0.5m in the first year, and accordingly raise both the asset value at the end of year 1 and the depreciation in year two by \$0.5m, the expected Excess Earnings would be as follows[46].

[46] The tax depreciation remains at \$5m per year because tax depreciation is determined solely by the initial cost of the asset.

$$E(Excess\ Earnings_1) = \$9.59m - \$3.1m - \$5m - .33[\$1.49m] + \$0.5m - .10(\$10m) = \$0.5m$$

$$E(Excess\ Earnings_2) = \$8.95m - \$3.2m - \$5.5m - .33[\$.75m] - .10(\$5.5m) = -\$0.55m$$

The present value of these Excess Earnings is zero, i.e., the same as when the revaluations are excluded. However, at the end of the first year (i.e., part way through the asset's life), the process will conclude that revenues are excessive. This conclusion is spurious, and is simply a consequence of evaluating performance part way through the asset's life *and* measuring Excess Earnings using a different approach to that underlying the setting of prices[47]. This points to the measurement of Excess Earnings disregarding revaluations for assets other than land if the business has not taken account of revaluations in setting its output price. Similarly, the process should recognise revaluations for assets other than land if the business has done likewise in setting its output price.

A caveat must now be mentioned, in the circumstance in which a business partially allows for revaluations in price setting, in the sense of raising its asset value and depreciation but failing to treat the revaluation as a source of income[48]. In this event the measurement of Excess Earnings must fully recognise or fully disregard revaluations. It must not adopt the partial policy of the business. Doing so would fail to detect the excess revenues resulting from the business' policy of partial allowance. This is illustrated using the previous example, except that the business sets its revenues so as to incorporate an increase in asset value at the end of the first year of \$0.5m, and an increase in year 2 depreciation of \$0.5m, but does not recognise this revaluation in year 1 as a source of income. The expected revenues in each of the two years are then as follows.

$$E(R_1) = \frac{.10(\$10m)}{1-.33} + \$3.1m + \$5m = \$9.59m, \quad E(R_2) = \frac{.10(\$5.5m)}{1-.33} + \$3.2m + \$5.5m = \$9.52m$$

The present value of these revenues, net of operating costs and taxes is as follows.

[47] The same spurious conclusion would arise if the IRR approach was adopted, because the IRR and Compounded Excess Earnings are equivalent (as shown in Appendix 3).

[48] This appears to have been done by some of the airfields in recent times.

$$V_0 = \frac{\$9.59m - \$3.1m - .33(\$1.49m)}{1.1} + \frac{\$9.52m - \$3.2m - .33(\$1.32m)}{(1.1)^2} = \$10.32m$$

The *NPV* is then \$0.32m. So, revenues are excessive as a result of the business employing the pricing strategy described. If the measurement of Excess Earnings treats revaluations in the same way in which some of the airfields appear to have in setting prices, then the expected Excess Earnings will be as follows:

$$E(ExcessEarnings_1) = [\$9.59m - \$3.1m - \$5m] - .33[\$1.49m] - .10(\$10m) = 0$$

$$E(ExcessEarnings_2) = [\$9.52m - \$3.2m - \$5.5m] - .33[\$1.32m] - .10(\$5.5m) = -\$0.17m$$

The present value of these Excess Earnings is negative, despite the revenues being excessive. So, this approach would be undesirable. By contrast, measuring Excess Earnings so as to completely disregard revaluations or completely recognize them will produce Excess Earnings that have a present value equal to the *NPV* of \$.32m. For example, completely disregarding them yields expected Excess Earnings of

$$E(ExcessEarnings_1) = [\$9.59m - \$3.1m - \$5m] - .33[\$1.49m] - .10(\$10m) = 0$$

$$E(ExcessEarnings_2) = [\$9.52m - \$3.2m - \$5m] - .33[\$1.32m] - .10(\$5m) = \$0.38m$$

and the present value is \$.32m. Nevertheless an evaluation conducted at the end of the first year would suggest that there were no excess profits.

In summary, regarding depreciable assets, if the business either fully allows for revaluations or fully disregards them in setting its output price, the measurement of Excess Earnings should do likewise. Adoption of a contrary policy would have no effect over the full course of the asset's life but could lead to spurious conclusions about excess profits in particular years if the evaluation was conducted part way through the asset's life[49]. However, if the business partially allows for revaluations in setting its output price, the measurement of Excess Earnings should not adopt the

[49] As the review period approaches the asset's life, the extent of any spurious conclusions will dampen down to zero.

same policy. To do so would fail to reveal excess profits. Instead the process should either fully allow for revaluations or fully disregard them. Such a policy will correctly reveal the extent of excess profits over the full course of the asset's life. It may not do so over any period less than this, but this cannot be avoided. Of course, this presents the question of determining which policy the business is observing. Some assistance can come from requiring disclosure in this area (as suggested by the Commerce Commission, 2002b, para 54). Even with this, there is room for error but it seems better to attempt alignment in this area than to simply ignore the issue and thereby risk attributing positive Excess Earnings to excess profitability rather than merely timing discrepancies.

Some of the submissions presented to the Commission argue for exclusion of some types of revaluations from the evaluation of excess profits. Dunedin Electricity (2003) argues that revaluations beyond the level of CPI inflation should be excluded, on the grounds that windfall real gains would be ignored in price setting by unregulated businesses. They appear to be suggesting that real revaluations should be excluded but the full asset value nevertheless invoked in determining depreciation and the cost of capital. Thus the business' prices would rise to reflect the increase in the latter two costs, with no offset from the revaluation. However, this would induce a downward bias in measuring Excess Earnings. To illustrate this fundamental point, suppose a business' only asset is land costing $10m, its cost of capital is .10 and it faces no other costs. Revenues of $1m per year will then be consistent with Excess Earnings of zero. Now, suppose the asset is revalued to $20m. If the revaluation of $10m is excluded from the measurement of Excess Earnings, the business will be able to double its revenues without giving rise to the judgement that excess profits exist. Thus, excluding revaluations (even those in excess of inflation) will disguise the earning of excess profits. In summary, one cannot exclude some revaluations from the measurement of Excess Earnings whilst still using the full asset value in determining depreciation and the cost of capital.

PwC (2003a) argues for excluding revaluations arising from the discovery of previously unvalued assets, as these discoveries are simply correcting earlier errors. I agree with this point. PwC also argues for excluding revaluations that arise from updating the ODV Handbook, because it would require major reductions in output prices to avoid a breach of the profit threshold. Like Dunedin Electricity, they appear to be suggesting that the revaluations be excluded from Excess Earnings but not from the asset value invoked in setting depreciation and cost of capital charges. However, revaluations arising from ODV updates are not conceptually different from more typical instances of revaluations, and the use of any RC methodology yields exposure to marked jumps in asset valuations. As illustrated in the preceding paragraph, the exclusion of some revaluations from the measurement of Excess Earnings (whilst still determining depreciation and the cost of capital on the full asset value) will give rise to a downward bias in measuring Excess Earnings.

In summary, with one exception, I do not consider that these arguments for omitting some revaluations from the measurement of Excess Earnings (whilst still determining depreciation and the cost of capital on the full asset value) are sustained. The one exception is in respect of newly discovered assets, and the treatment of these should accord with the normal process for correcting errors.

3.5 Depreciation

Paralleling the situation for revaluations of depreciating assets, any measurement of Excess Earnings should invoke the same depreciation schedule used by the business in setting its output price. Failure to do so may lead to spurious conclusions about the existence of excess profits when a calculation is done part way through the asset's life. To illustrate this, the example at the beginning of section 3.4 is employed. In this case the expected revenues are set using depreciation of \$5m per year, i.e.,

$$E(R_1) = \frac{.10(\$10m)}{1-.33} + \$3.1m + \$5m = \$9.59m, \quad E(R_2) = \frac{.10(\$5m)}{1-.33} + \$3.2m + \$5m = \$8.95m$$

The present value of these revenues, net of operating costs and tax, is as follows.

$$V_0 = \frac{\$9.59m - \$3.1m - .33(\$1.49m)}{1.1} + \frac{\$8.95m - \$3.2m - .33(\$.75m)}{(1.1)^2} = \$10m$$

This matches the initial investment of \$10m, and so the *NPV* is zero, i.e., the expected revenues just cover the costs. However, if the measurement of Excess Earnings employs a depreciation schedule that assigns \$7m in the first year and \$3m in the second rather than \$5m per year, the expected Excess Earnings in each of the two years would be as follows.

$$E(ExcessEarnings_1) = \left[\$9.59m - \$3.1m - \$7m\right] - .33[\$1.49m] - .10(\$10m) = -\$2m$$

$$E(ExcessEarnings_2) = \left[\$8.95m - \$3.2m - \$3m\right] - .33[\$0.75m] - .10(\$3m) = \$2.2m$$

The present value of these Excess Earnings is zero. However, at the end of the first year, the measurement of Excess Earnings would suggest the spurious conclusion that profits were inadequate. This perverse result would simply be a consequence of the calculation using a depreciation schedule that differs from that used by the business in setting its output price.

3.6 Revaluations and Optimisations

This section examines the implications of optimising out assets in the course of invoking the ODV asset valuation methodology. In this event, the subsequent depreciation and cost of capital figures are reduced. It might seem that such optimisation events should constitute a revaluation of the asset to zero, and this should be include within the “Revaluations” term in measuring Excess Earnings (see equation (7) on page 45). However, this is not the case, as it circumvents the very act of reducing depreciation and cost of capital, leaving the business with the ex-ante compensation (possibly in the form of a “margin on WACC”) as a gift[50].

Consider the following example. A business has just purchased an asset costing \$100m, with a life of one year. In addition, and for the purpose of simplifying the example, the business has no other assets, no operating costs and faces no taxation. Finally, its WACC is .10. The business’ revenues are received at the end of the year.

[50] The same point arises if the Commission removes stranded assets from the cost base used to determine excess profits.

The business will then set the revenues to cover depreciation and cost of capital, as follows:

$$R_1 = \$100m + (.10)\$100m = \$110m$$

The present value of these revenues is $100m, matching the business' initial investment, and therefore yielding a project with NPV of zero. If the business is not subject to assets being optimised out, the Excess Earnings measured at the end of the year following equation (7) will be zero as follows:

$$ExcessEarnings_1 = \$110m - \$100m - (.10)\$100m = 0$$

This is consistent with an NPV of zero. If, instead, the business is subject to assets being optimised out, then it is exposed to the possibility of its costs in the last equation being reduced. This will generate positive Excess Earnings, which will incline the business towards lowering its revenues so as to avoid the risk of price control. Some compensation must be granted for this, and I assume here that it takes the form of a "margin on WACC". The size of this increment must reflect the expected level of optimisations, i.e., if the actual level of optimisations matches the expected level, the Excess Earnings must still be zero. Suppose the expected level of optimisation is $5m, arising shortly before the end of the year. Without an increment to WACC, the Excess Earnings will be determined to be positive as follows

$$ExcessEarnings_1 = \$110m - \$95m - (.10)\$100m = \$5m$$

The required increment to WACC must reduce this to zero, and is therefore .05, i.e.,

$$ExcessEarnings_1 = \$110m - \$95m - \$100m(.15) = 0$$

These calculations have not treated the removal of a $5m asset as a "Revaluation" event. If this were done, it would simply offset the reduction in depreciation and the Excess Earnings would then be calculated as -$5m as follows:

$$ExcessEarnings_1 = \$110m - \$5m - \$95m - \$100m(.15) = -\$5m$$

This would constitute a gift to the business because it could then raise its revenues by $5m without incurring any risk of price control.

In summary, if a Lines Business is subject to the possibility of assets being optimised out as in the application of the ODV asset valuation methodology, any resulting removals of assets should not be treated as "Revaluation" events for the purpose of measuring Excess Earnings.

3.7 The Joint Cost Problem

The examination of excess profits will be undertaken solely in respect of the Lines Businesses, and these are only part of the activities of the companies within which the Lines Businesses are embedded. In particular, in the period prior to 1999, the companies embodied both lines and energy businesses. This leads to problems of allocating joint costs between the two businesses. Since 1995, the companies were required to undertake such joint costs allocations, in the course of producing separate earnings statements for the two activities. The purpose of this requirement was clearly to enable external parties to evaluate the extent of any excess profits in the Lines Businesses, and therefore the companies would have had the incentive to bias the allocation of costs towards the Lines Businesses. This suggests that the companies' own allocations cannot be taken at face value.

4. Estimating and Using WACC in Further Investigations

Having implemented a profit threshold, the resulting examination of profits may lead to the view that a particular Lines Business has breached the threshold. This may lead to further investigation of profits. In respect of this further investigation, the question then arises as to whether the WACC employed, and the process of incorporating it into an investigation of excess profits, would differ from those in the initial examination. In my view there are three points at which variation in practice is required.

The first of them has already been discussed earlier in section 2.6, and is included here for completeness. In conducting further investigations, and providing that the business' actual costs were examined rather than efficient costs, it would be appropriate to acknowledge the business' actual leverage level, along with a compatible debt premium. As indicated in section 2.6, the maximum effect of this would be to change the WACC by about .30%.

The second point arises from the fact that the initial examination will involve past profits whereas any subsequent investigation will involve both past and prospective profits. In undertaking these investigations, there are areas of doubt. In particular there is room for doubt over WACC estimates (most particularly the asset betas and the market risk premium), allocations of joint costs, and forecasts of revenues and costs. To this must be added the problem of measurement error. In recognition of both points, point estimates should be accompanied by bands of uncertainty, and this corresponds to the practice recommended in section 2 of this paper as well as the Commission's practice in the Airfields Report. However the room for doubt must be greater in respect of future revenues and costs, and therefore the bands of uncertainty in respect of them should be widened accordingly.

The third point of variation is over the size of these bands, at least in respect of WACC and joint cost allocations. The purpose of the initial examination is to identify a set of potential breaches of the threshold, with the subsequent investigation narrowing this set down. This point suggests that the bands of uncertainty in the subsequent investigation should be wider than in the initial examination. However there is a countervailing factor in respect of costs and revenues, arising from the fact that the period of examination will be larger in the subsequent investigation. An expansion in the period of investigation reduces exposure to transitory cost and revenue events, and also measurement errors. This permits a narrower band whilst maintaining the same level of confidence. This is akin to expanding a sample size, when conducting a statistical test of a hypothesis.

Boyle and Guthrie (2002) hint at the necessity for a classical statistical analysis, i.e., do the data allow one to reject the null hypothesis that the mean of the population from which Excess Earnings are drawn is zero. However the data here lack the essential property of independence for conducting such a test. Furthermore the data suffer not just from the possibility of being unrepresentative but also from the possibility of measurement and estimation error. Nevertheless it remains true that Excess Earnings must be not merely positive but sufficiently so before one can conclude that monopolistic behaviour is present. Rather than applying a classical statistical test, one must attach bounds to their point estimates and these bounds are a matter of judgement. Various submissions reiterate this point (for example, LECG, 2003) but offer no methodology for estimating the appropriate size of the margin.

5. Estimating WACC in Setting a Price Cap

In the event of further investigating an apparent breach of the profit threshold by a Lines Business, and concluding that a breach had occurred, the Commission may then choose to impose a price cap upon that business. This section considers whether the WACC used in setting the price cap should differ from that used in the earlier investigations. Several points of difference arise, as follows.

First, the estimation of WACC in the earlier investigations must reflect the environment in which the business operates. In particular, it must reflect the fact that the business is not subject to a price cap at that point. By contrast, once the price cap is imposed, the WACC used in setting the price cap must reflect the existence of that price cap. Whether this raises or lowers the WACC depends upon the nature of the price cap. In particular, it depends upon the interval of time before the price cap is revised. As discussed earlier, the longer is this interval, the higher is the asset beta faced by the Lines Businesses, and therefore the higher will be the WACC. For example, if the price cap were for five years, then the asset beta suggested by the analysis in section 2.4 would be .40-.50 (being .30 for one year price caps plus an increment of .10-.20 for five year caps). Accordingly the lower bound, point estimate and upper bounds for WACC presented in section 2.9 would be revised as shown below. The higher asset beta attributed to the price capped situation with a five year cycle, compared to the situation prior to the imposition of a price cap, is due to the price cap situation being equated with the situation facing UK regulated electricity firms, whereas the prior situation is equated with circumstances between those of US and UK firms.

ϕ	R_f	β_a	L	p	k_e	$WACC$
.06	.055	.40	.40	.012	.077	.064
.07	.055	.45	.40	.012	.089	.072
.08	.055	.50	.40	.012	.104	.080

Second, the estimation of WACC in the earlier investigations employs bands to reflect uncertainty about the true value of this parameter. However, in respect of setting a price cap, a single number must be settled upon. Of course, that number might be drawn from the upper or lower end of the band rather than the middle. I favour drawing it from the upper end, so as to reduce the risk of setting a WACC that was too low. This is the more serious of the two possible errors because it may lead to a firm failing to reinvest. In the table just presented I would therefore favour the last row over the middle row.

Third, as demonstrated in Lally (2002a), the term of the risk free rate used in price capping should accord with the term of the price capping. Thus, if prices were capped for five years, then the relevant risk free rate should be the five year rate prevailing at the date at which capping was initiated. This issue does not arise so clearly in assessing whether breaches of a profit threshold have occurred, because prices are not so clearly fixed for a defined period.

Fourth, in respect of leverage and the associated debt premium, I have argued that estimates of excess profits should draw upon actual or optimal leverage (and the associated debt premium) according to whether actual or efficient costs are invoked. In respect of setting a price cap, efficient costs should be at least considered. Accordingly, optimal rather than actual leverage should be at least considered, especially since a business faces few obstacles in adjusting its leverage in line with any view reached on this matter by the regulator. Sections 2.5 and 2.6 have suggested an optimal leverage of .40 and a debt premium of .012 respectively.

The final point concerns asymmetric risks. These comprise the risks of assets being stranded, of assets being optimised out by the Commission, and of miscellaneous exposures to such events as adverse (and uninsurable) weather conditions. In the context of setting a price cap, the Commission must determine whether to deal with these risks through ex-ante compensation (possibly via an addition to WACC) or through ex-post compensation (if and when the events occur)[51]. Ex-ante allowance implies that investors bear the risk whereas ex-post allowance implies that (future) consumers bear the risk. Ex-ante compensation suffers from the difficulty that it is simply impossible to know what the appropriate level should be. Thus, to ensure investment is forthcoming, one must err on the generous side[52]. Even this may not be enough. If an extreme asymmetric event occurs to the extent that the ex-ante compensation received up until that time is insufficient, the regulated business is liable to claim that the ex-ante compensation should be raised. By contrast, if the asymmetric events do not occur to the extent envisaged, the regulated business will remain silent. So, even if the ex-ante allowance is appropriate, there will still be a bias towards subsequent increases. To draw an analogy, when governments choose to compensate farmers for extreme weather conditions, they do so ex-post rather than ex-ante for the reasons just noted. Nevertheless, ex-post compensation also suffers from certain disadvantages. Firstly, businesses then lack proper incentives to avoid or mitigate such adverse events. Secondly, there is always the possibility of ex-post compensation being denied, such as in the case of actions by businesses that are judged to be grossly imprudent by the regulator. Since there will always be uncertainty on the part of the businesses as to the regulator's decisions in this area, then a regulator's promise to provide ex-post compensation must be worth less than face value, in which case businesses face a disincentive to invest.

[51] Ex-post compensation would take the form of increasing prices to other consumers, or to the same consumers in the form of accelerated depreciation in the face of a downward revision in an asset's residual life. For example, an asset might have an anticipated life of 20 years at the time of purchase. After 5 years, it becomes clear that it will be stranded in five years. At this point, the depreciation allowance would be raised so as to depreciate the asset fully over the next 5 rather than 15 years. This is broadly consistent with the approach required by accounting standards.

[52] An exception to this is in respect of optimisation risk whenever businesses have a choice of whether they are exposed to it, through a choice of a DHC or ODV asset valuation basis. In this case, the act of choosing to be subject to optimisation risk implies an acceptance of the ex-ante compensation offered.

The views of the Australian regulators on this question are instructive. In respect of price caps for Victorian gas distributors, the ACCC (1998) seems to have explicitly chosen an asset beta from the upper region of the band in order to compensate investors ex-ante for bearing such asymmetric risks. However no quantitative analysis supported this feature of the decision. Since then the ACCC has clearly disavowed that approach. In particular it favours mitigating such risks through such devices as accelerated depreciation (ACCC, 1999, 2001). Otherwise, it recommends explicit identification of the risks along with appropriate adjustment of the cash flows, although the mechanics of this are not articulated. In the ORG's recent decision concerning Victorian electricity distributors (Office of the Regulator General, 2000) the principal form of these cash flow adjustments appears to be through conservative (i.e., enlarged) estimates of costs, and asset stranding was considered too unlikely to warrant adjustment. These experiences suggest that it is very difficult to make ex-ante adjustments for asymmetric risks.

6. Conclusions

This paper has examined the estimation of nominal WACC and its application to estimating excess profits and setting a price cap (on the assumption that this is required). The primary conclusions are as follows. Regarding the estimation of nominal WACC for setting a profit threshold, the model recommended is that used in the Airfields Report. In addition the parameter values recommended are a market risk premium of 7% along with bands of 6-8% (compared to 7-9% in the Airfields Report), use of the three year risk free rate (although there are pragmatic advantages to using the rate corresponding to the period of the profit examination), an asset beta for all of the Lines Businesses of .40 with bands of .30-.50, leverage of .40, and a debt premium of 1.2%. The form of ownership of the Lines Businesses should not be a factor in estimating the WACC, except in so far as it affects the asset beta, and this appears impossible to quantify. Using these parameter values, and the three (or five) year risk free rate of 5.5% (March 2003 average), the lower limit on WACC, the point estimate, and the upper limit are 5.8%, 6.8% and 8.0% respectively. If a Lines Business were subject to the possibility of assets being optimised out of the costs used to evaluate excess profits, as in the ODV asset valuation methodology, then some form of ex-ante compensation would be indicated, such as a "margin on WACC".

Similarly, if it were subject to the possibility of costs associated with stranded assets being removed from the cost base used to determine excess profits, then again some form of ex-ante compensation would be indicated.

In respect of employing the WACC to determine a profit threshold, and then to examine whether breaches have occurred, two approaches are suggested. The first is to calculate the Excess Earnings for each year, and then compound these forward to the date of the review, as in the Airfields Report. The second is a variant on the IRR methodology, involving calculation of the premium earned relative to the cost of capital. The use of compounded Excess Earnings has the advantage of expressing the outcome in dollar terms, and the contributions of individual years to any breach are immediately apparent. The use of an IRR premium has the advantage of expressing the outcome in rate of return terms. In applying either of these methods, the issue of asset revaluations arises, and the conclusions reached in the Airfields Report are affirmed. In particular, land revaluations must be incorporated into the evaluation of excess profits, regardless of whether the Lines Businesses have recognised them in setting their output prices; failure to do so will lead to inappropriate conclusions. By contrast, in respect of revaluations for other assets, they should be included or excluded from the measurement of excess profits according to whether the Lines Businesses have included or excluded them in setting their output prices. Depreciation should be treated in the same way as the revaluations on depreciating assets, i.e., the numbers used should accord with those reflected in the Lines Businesses output prices. If a Lines Business is evaluated against an ODV asset valuation base, any resulting optimisations should not be included within "Revaluations" in the definition of Excess Earnings. Similarly, if stranded assets are removed from the cost base in determining Excess Earnings, these events should not be included within "Revaluations" in the definition of Excess Earnings.

If a profit threshold is implemented, and it is determined that a breach has occurred, further investigation may then occur into past and prospective profits. In carrying out this second step, the same principles used in the first step should be observed, with three exceptions. Firstly, in conducting further investigations, and providing that the Lines Businesses actual costs are examined rather than efficient costs, it would be appropriate to acknowledge the Lines Businesses actual leverage level, along with a compatible debt premium. Secondly, the bands of uncertainty around projected revenues and costs should be larger than for past revenues and costs. Finally, the bands in respect of WACC and joint cost allocations may differ from those in the first step, on account of the presence of more data (which leads to a narrower band) and the need to reduce the set of possible breaches (which leads to a wider band).

Having carried out these investigations, a price cap may then be imposed upon a Lines Business. In doing so, the WACC estimate employed may differ from that used in the earlier two steps, and the points of difference are as follows. First, the imposition of a price cap may change the appropriate asset beta for the Lines Business. In particular, the use of a five year regulatory cycle implies a larger asset beta than before the imposition of the price cap. Second, the bands around WACC must now be replaced by a point estimate. Third, the term of the risk free rate must accord with the term of the price cap. Fourth, the choice of actual versus optimal leverage (and the associated debt premium) may differ. Finally, in respect of asymmetric risks, the Commission would have to decide whether to incorporate an ex-ante allowance for them into the Lines Businesses output price, or offer ex-post compensation in the event of relevant events occurring.

APPENDIX 1

This appendix proves that the compounded Excess Earnings over the life of a project is equal to the ex-post NPV compounded forward to the end of the project's life. To simplify the proof, the project is assumed to have a life of two years. The initial investment in the project is designated B_0. Let CF_t be the operating cash flow for the year ending at time t, CAP_t be the capital expenditure for the year ending at time t, and k_t be the discount rate for year t. The ex-post NPV is then

$$NPV = \frac{CF_1 - CAP_1}{1+k_1} + \frac{CF_2 - CAP_2}{(1+k_1)(1+k_2)} - B_0$$

It follows that

$$(B_0 + NPV)(1+k_1) = CF_1 - CAP_1 + \frac{CF_2 - CAP_2}{1+k_2}$$

and hence that

$$B_0 + NPV(1+k_1) = CF_1 - CAP_1 - B_0 k_1 + \frac{CF_2 - CAP_2}{1+k_2} \qquad (8)$$

The initial book value of assets can be expressed as

$$B_0 = B_1 + DEP_1 - REV_1 - CAP_1$$

where DEP_1 is depreciation for the year ended at time 1 and REV_1 are the revaluations for the year ended at time 1 . Substituting this into equation (8), and simplifying, yields

$$B_1 + NPV(1+k_1) = CF_1 + REV_1 - DEP_1 - B_0 k_1 + \frac{CF_2 - CAP_2}{1+k_2}$$

It follows that

$$B_1 + B_1 k_2 + NPV(1+k_1)(1+k_2) = (CF_1 + REV_1 - DEP_1 - B_0 k_1)(1+k_2) + CF_2 - CAP_2 \tag{9}$$

Since the book value B_2 is zero then

$$B_1 = DEP_2 - REV_2 - CAP_2$$

Substituting this into equation (9), and simplifying, yields

$$NPV(1+k_1)(1+k_2) = [CF_1 + REV_1 - DEP_1 - B_0 k_1](1+k_2) + [CF_2 + REV_2 - DEP_2 - B_1 k_2] \tag{10}$$

The Excess Earnings in year t is operating cash flow plus revaluations, less depreciation and cost of capital, i.e.,

$$Excess\ Earnings_t = CF_t + REV_t - DEP_t - kB_{t-1}$$

The right hand side of equation (10) is then the compounded Excess Earnings, and the left hand side is the ex-post NPV compounded to the end of the project's life. This completes the proof. The reasoning here parallels that in Ohlson (1995).

APPENDIX 2

This appendix examines the question of how the timing of capital expenditures, disposals and revaluations should be handled in the context of calculating Excess Earnings. In particular, it considers whether their exact timing should be recognised or whether they should be treated as occurring at some other time, such as at the end of the year.

Capital Expenditures

The timing of capital expenditures is a real as opposed to an accounting event and therefore their exact timing should be recognised in assessing the Excess Earnings of an entity. The only justification for delaying their recognition until the end of the year (or treating them as if they occurred midway through the year) is that the resulting error will be modest. Whether this is true is an empirical issue.

To illustrate this point, the following example is invoked. A project is initiated now with assets of \$100m and a life of two years. In addition further capital expenditures of \$50m will be required one month into the second year, and these will have a life of eleven months. The cost of capital is 10%, and there are no further costs. The project revenues (received in one and two years time) are set so as just to cover its costs. Accordingly its revenues for each year are the sum of depreciation (*DEP*) and the cost of capital, with the cost of capital being the 10% rate applied to the asset book value (*BV*) at the beginning of the period (or a lower rate in respect of assets acquired after the beginning of the year). In respect of the further capital expenditures (*CAP*), the appropriate cost of capital will be 10% for eleven months, i.e., 9.13% following the compounding law. Also, the depreciation schedule for the assets is \$70m in the first year and \$30m in the second. So the revenues will be set at

$$R_1 = DEP_1 + .10BV_0 = \$70m + .10(\$100m) = \$80m$$

$$R_2 = DEP_2 + .10BV_1 + .0913(CAP) = \$80m + .10(\$30m) + .0913(\$50m) = \$87.56m$$

The present value of the resulting future cash flows is then

$$V_0 = \frac{\$80m}{1.10} - \frac{\$50m}{(1.10)^{1.083}} + \frac{\$87.56m}{(1.10)^2} = \$100m$$

This matches the initial expenditures and therefore confirms that the revenues just cover the project's costs.

We now turn to the calculation of Excess Earnings. If the calculation recognises the exact timing of the capital expenditures then

$$ExcessEarnings_1 = R_1 - DEP_1 - .10BV_0 = \$80m - \$70m - .10(\$100m) = 0$$

$$\begin{aligned} ExcessEarnings_2 &= R_2 - DEP_2 - .10BV_1 - .0913(\$50m) \\ &= \$87.56m - \$80m - .10(\$30m) - .0913(\$50m) = 0 \end{aligned}$$

So the Excess Earnings are zero in each year, consistent with the revenues just covering costs. By contrast, if the capital expenditures in the second year were treated as if they occurred at the end of the year rather than the beginning, then the Excess Earnings for year 2 would have been as follows.

$$ExcessEarnings_2 = R_2 - DEP_2 - .10BV_1 = \$87.56m - \$80m - .10(\$30m) = \$4.56m$$

This would indicate that the project's revenues were too large in relation to its costs, which is not correct. The overstatement is around 6% of the asset value.

In summary, in assessing Excess Earnings, the precise timing of capital expenditures within a year should be reflected in the calculation of the cost of capital to ensure results that are consistent with the underlying economic situation. If not, then the results will be misleading. Whether the degree of misstatement is significant will be case specific. So, in so far as the errors that would otherwise arise are sufficiently large to make it necessary to recognise the exact timing of capital expenditures, the conclusions in respect of major capital expenditures differ from those in respect of minor capital expenditures: recognise the exact timing of major capital expenditures and treat the rest as if they occurred at year end. If the errors that would otherwise arise are too small to make it necessary to recognise the exact timing of capital expenditures, then one should treat all capital expenditures as if they occurred at the end of the year. A possible approximation is to act as if all capital expenditures occur mid-way through the year.

Capital Disposals

It might be thought that disposals warrant the same treatment as expenditures. For example, if an asset is disposed of during the year, then the allowance for the cost of capital must be reduced in accordance with the timing of the disposal. This is not in fact the case, i.e., one can act as if the asset is disposed of at year end. The reason for the difference in treatment is the fact that a disposal is not a cash event and therefore timing is unimportant. Put another way, the depreciation schedule is immaterial and depreciating the asset over one year as opposed to six months are simply two possible depreciation schedules. Depreciating over one year is equivalent to recognising disposal of the asset at the end of the year and depreciating over six months to recognising disposal in six months. So, the point at which disposal is recognised is immaterial.

To illustrate this, consider the following example. A project involves purchasing an existing asset for \$50m, and the asset is exhausted in six months. At that point another such asset is purchased for \$55m and this too is exhausted in six months. The cost of capital is 10% and there are no other costs. The project revenues (received in one year) are set so as to just cover the costs. So, the revenues received in one year are the sum of depreciation and the cost of capital, with the latter being a full year's allowance on the initial asset and six months allowance (4.88%) on the second asset. The revenues are then as follows.

$$R_1 = DEP_1 + .10(\$50m) + .0488(\$55m) = \$105m + .10(\$50m) + .0488(\$55m) = \$112.68m$$

The present value of the future cash flows is then

$$V_0 = \frac{\$112.68m}{1.10} - \frac{\$55m}{(1.10)^{0.50}} = \$50m$$

This equals the initial expenditure of \$50m and therefore confirms that the revenues just cover the project's costs. In calculating the Excess Earnings, the cost of capital allowance is for a full year on the \$50m expenditure (i.e., act as if disposal occurs in one year) and six months on the \$55m expenditure, as follows.

$$ExcessEarnings_1 = R_1 - DEP_1 - .10(\$50m) - .0488(\$55m)$$
$$= \$112.68m - \$105m - .10(\$50m) - .0488(\$55m) = 0$$

The outcome of zero is consistent with the revenues just covering its costs.

In summary, in calculating Excess Earnings, one can act as if asset disposals during a year occur at the end of that year.

Revaluations

If revaluations are undertaken by the business part-way through a year, the calculation of Excess Earnings can be performed as if they were undertaken at the end of the year. This conclusion differs from that in respect of capital expenditures because the timing of capital expenditures are real events (cash flows are affected) whereas the timing of revaluations are not.

To illustrate this principle, consider the following example. We start with an example without revaluations, then introduce revaluations at year end, and finally consider revaluations undertaken part-way through a year. A project is initiated now with assets of \$100m and a life of two years. The cost of capital is .10, and there are no further costs. The project's revenues (received in one and two years time) are set so as just to cover its costs. Accordingly its revenues for each year are the sum of depreciation (*DEP*) and the cost of capital, with the cost of capital being the 10% rate applied to the asset book value (*BV*) at the beginning of the period. The assumed depreciation schedule on the initial assets is 50% in the first year and 50% in the second. So the revenues will be set at

$$R_1 = DEP_1 + .10BV_0 = \$50m + .10(\$100m) = \$60m$$

$$R_2 = DEP_2 + .10BV_1 = \$50m + .10(\$50m) = \$55m$$

The present value of the resulting cash flows is

$$V_0 = \frac{\$60m}{1.10} + \frac{\$55m}{(1.10)^2} = \$100m$$

This matches the initial expenditures and therefore confirms that the revenues just cover the project's costs.

We now turn to the calculation of Excess Earnings.

$$ExcessEarnings_1 = R_1 - DEP_1 - .10BV_0 = \$60m - \$50m - .10(\$100m) = 0$$

$$ExcessEarnings_2 = R_2 - DEP_2 - .10BV_1 = \$55m - \$50m - .10(\$50m) = 0$$

So the Excess Earnings are zero in each year, consistent with the revenues just covering costs.

We now consider what happens if the asset is revalued at the end of the first year, by \$20m. The revenues would then be reset as follows.

$$R_1 = DEP_1 + .10BV_0 - REVAL_1 = \$60m + .10(\$100m) - \$20m = \$50m$$

$$R_2 = DEP_2 + .10BV_1 = \$60m + .10(\$60m) = \$66m$$

The present value of the resulting cash flows is

$$V_0 = \frac{\$50m}{1.10} + \frac{\$66m}{(1.10)^2} = \$100m$$

The Excess Earnings are as follows.

$$ExcessEarnings_1 = R_1 - DEP_1 - .10BV_0 + REVAL_1$$
$$= \$50m - \$60m - .10(\$100m) + \$20m = 0 \qquad (11)$$

$$ExcessEarnings_2 = R_2 - DEP_2 - .10BV_1 = \$66m - \$60m - .10(\$60m) = 0$$

So the introduction of revaluations changes the distribution of the firm's revenues over time but the present value of these revenues is still equal to the initial expenditure of \$100m. Consistent with this, the Excess Earnings are still zero in each year.

We now suppose that the \$20m revaluation is undertaken mid-way through the first year, and that the precise timing is recognised. Only the calculation of the project's revenue for the first year is affected, as follows. A revaluation has two dimensions. First, the revaluation increases the asset level mid-way through the first year; the cost of capital for the first year must be raised to reflect this in the same way as for capital expenditures (the rate will be 4.88% to reflect a period of six months). Second, and consistent with this, the revaluation must be treated as if it was income received mid-way through the year; it must then be compounded forwards to the end of the year (at the 10% rate for six months, i.e., 4.88%). The revenue set for the first year would then be as follows.

$$R_1 = DEP_1 + .10BV_0 + .0488REVAL - REVAL(1.0488)$$
$$= \$60m + .10(\$100m) + .0488(\$20m) - \$20m(1.0488) = \$50m$$

So, the revenue allowed for the first year would be unaffected. The Excess Earnings calculation should be subject to the same two adjustments, i.e., the cost of capital should be increased to reflect the addition to the asset base mid-way through the first year, and the revaluation "income" should be compounded forwards to the end of the year, as follows.

$$ExcessEarnings_1 = R_1 - DEP_1 - .10BV_0 - .0488REVAL + REVAL(1.0488)$$
$$= \$50m - \$60m - .10(\$100m) - .0488(\$20m) + \$20m(1.0488) = 0$$

However, it is contrary to standard accounting practice to compound forwards income received part way through the year to the year end. Nevertheless it is necessary to do this if the cost of capital is raised to reflect the revaluation part way through the year. An alternative to this approach would be to simply treat the revaluations as if they occurred at the end of the year. This appears in equation (11) above. Clearly this is simpler, accords with standard accounting practice, and yields the same outcome. Therefore it is preferred.

In summary, if revaluations occur part-way through a year (as opposed to being at the year end), the calculation of Excess Earnings can still be done as if the revaluation occurred at the end of the year. The example used here is of a depreciating asset. However the general principle applies equally to land.

Conclusion

This appendix has examined the question of whether, in the context of calculating Excess Earnings, capital expenditures, disposals and revaluations that occur part way through a year should be treated as if they occurred at the time that they actually did or at some other time. The conclusions are as follows. In respect of capital expenditures, recognition of the precise timing through the allowance for the cost of capital is necessary to produce Excess Earnings results that are consistent with the underlying economic situation. However the error from acting as if they occurred at year end may not be substantial, and will not be substantial in respect of minor capital expenditures. In respect of disposals, one should act as if the disposal occurred at the end of the year. In respect of revaluations, the same policy of treating the event as if it occurred at the end of the year should be observed.

So, in so far as the errors that would otherwise arise are sufficiently large to make it necessary to recognise the exact timing of capital expenditures, the conclusions in respect of major capital expenditures differ from those in respect of minor capital expenditures, disposals and revaluations: recognise the exact timing of major capital expenditures and treat the rest as if they occurred at year end. If the errors that would otherwise arise are too small to make it necessary to recognise the exact timing of capital expenditures, the conclusions in respect of capital expenditures are the same as those in respect of disposals and revaluations: treat them all as if they occurred at the end of the year. A possible approximation in respect of capital expenditures is to act as if they all occurred mid-way through the year. This should not be done in respect of disposals and revaluations.

APPENDIX 3

This appendix proves that the compounded Excess Earnings over a review period are equivalent to the premium embedded in the IRR for that period, i.e., if the former is positive (negative), then the latter is also positive (negative). To simplify the presentation, a review period of two years is assumed. The IRR premium p then solves the following equation

$$B_0 = \frac{CF_1 - CAP_1}{1 + k_1 + p} + \frac{CF_2 - CAP_2 + B_2}{(1 + k_1 + p)(1 + k_2 + p)}$$

where B_2 is the book value of the project's assets at the end of the review period. This equation can be expressed as

$$B_0 + \alpha = \frac{CF_1 - CAP_1}{1 + k_1} + \frac{CF_2 - CAP_2 + B_2}{(1 + k_1)(1 + k_2)}$$

where α is the dollar counterpart to the premium p, i.e., α is positive (negative) if the premium p is positive (negative). It follows that

$$B_0 + \alpha(1 + k_1) = CF_1 - CAP_1 - B_0 k_1 + \frac{CF_2 - CAP_2 + B_2}{1 + k_2} \qquad (12)$$

The initial book value of the assets can be expressed as

$$B_0 = B_1 + DEP_1 - REV_1 - CAP_1$$

Substituting this into equation (12), and rearranging, yields

$$B_1 + \alpha(1 + k_1) = CF_1 + REV_1 - DEP_1 - B_0 k_1 + \frac{CF_2 - CAP_2 + B_2}{1 + k_2} \qquad (13)$$

The book value of the assets at time 1 can be expressed as

$$B_1 = B_2 + DEP_2 - REV_2 - CAP_2$$

Substituting this into equation (13), and rearranging, yields

$$\alpha(1+k_1)(1+k_2) = [CF_1 + REV_1 - DEP_1 - B_0 k_1](1+k_2) + [CF_2 + REV_2 - DEP_2 - B_1 k_2]$$

The right hand side is the compounded sum of the Excess Earnings for each year. So, if the premium p embedded in the IRR is positive (negative), then α is positive (negative), and so the compounded sum of the Excess Earnings is positive (negative). This completes the proof.

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