THE WEIGHTED AVERAGE COST OF CAPITAL FOR ELECTRICITY LINES BUSINESSES

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CONTENTS

EXECUTIVE SUMMARY

This paper supersedes an earlier version that was publicly released by the Commerce Commission (the Commission) on 8 August 2003. In providing advice to the Commission in this paper, submissions received by the Commission on the earlier version of the paper have been taken into account and specifically addressed where required.

On 31 March 2003, the Commission 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 to adopt price and quality thresholds but not also a profit threshold. If the price or quality thresholds are breached, then a forward-looking assessment of excess profits may be undertaken. Such investigations in turn may lead to the imposition of a price cap. Amongst these processes, both the assessment of excess profits and the 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 of these two steps, 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 assessing excess profits, the model recommended is that used in the Airfields Report. In addition the parameter values recommended are a market risk premium of 7% (compared to 8% in the Airfields Report), use of the three year risk free rate (set at the beginning of the review period and used throughout it), an asset beta for all of the lines businesses of .40, leverage of .40, and a debt premium of 1.2%. If debt issue costs can be readily identified in the firm’s cash flows, they should be excluded and a margin of .3% added to the cost of debt. 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 this model, these parameter values, and the three year risk free rate of 6.3% (April 2005 average), the point estimate on WACC is 7.3% (adding debt issue costs to the cost of debt raises this figure to 7.4%). In recognition of possible estimation errors for some of these parameters, the standard deviation of the WACC estimate is estimated at 1.1%. Other types of possible errors are not open to quantification in this way.

This WACC estimate may be adjusted to take account of additional issues that are not inherently WACC issues. Asymmetric risks present certain difficulties. In so far as the possibility of asset stranding and miscellaneous adverse risks such as natural disasters are dealt with by firms raising their output prices ex-ante, this gives rise to the problem that forward-looking assessments of excess profits will be incorrect unless cost forecasts reflect the expected incidence of these events, possibly through a margin added to WACC along with removal of any such costs that are already impounded into the cost forecasts. In addition, 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 may be warranted. 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 may be warranted.

In respect of the costs of financial distress, the situation in principle is similar to that of asset stranding and natural disasters. However, even if firms raise their prices ex-ante in compensation for the possibility of financial distress, and a regulator was able to identify any costs of this type that were already impounded into the cost forecasts, no convincing evidence is available that the appropriate ex-ante adjustment to output prices is substantial. Accordingly, I favour no increment to WACC or otherwise to cash flows for the costs of financial distress borne by shareholders. In so far as this is disadvantageous to the firms, this is part of a broader collection of judgements, and some of them are advantageous to the firms. In particular, the use of a domestic rather than an international version of the CAPM is likely to be advantageous to firms.

Finally, in respect of timing options, firm resource constraints, and information asymmetries, I do not consider that any margin should be added to WACC for the purpose of assessing excess profits.

In respect of the process by which a WACC estimate is used to assess excess profits, two approaches are suggested. The first is to determine the Present Value of Excess

Earnings over the future review period, and this present value could be converted into an annual equivalent. The second is a variant on the IRR methodology, involving calculation of the expected rate of return premium relative to the cost of capital. The Present Value of Excess Earnings has the advantage of expressing the outcome in dollar terms, and the contributions of individual years 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 depreciating assets, they should be included or excluded from the assessment 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, and is granted ex-ante compensation for this, 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 evaluating Excess Earnings, these events should *not* be included within "Revaluations" in the evaluation of Excess Earnings.

Having carried out this assessment of excess profits, a price cap may then be imposed upon a lines business. In doing so, the WACC estimate employed may differ from that used in evaluating excess profits, 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, any bands around WACC must now be replaced by a single figure, and a figure in excess of the point estimate is recommended. Third, the term of the risk free rate must accord with the term of the price cap. Finally, in respect of asymmetric risks, the Commission would have to decide whether to incorporate an ex-ante allowance for them into the output price, or offer ex-post compensation in the event of relevant events occurring.

1. Introduction

On 31 March 2003, the Commission 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 to adopt price and quality thresholds but not also a profit threshold. If the price or quality threshold is breached, then an assessment of excess profits may be undertaken, of the forward-looking type. Such an investigation may in turn lead to the imposition of a price cap. Amongst these processes, both the assessment of excess profits and the 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 of these two steps, assuming for the purposes of this advice that each step is undertaken.

Section 2 of this paper commences by presenting a model for estimating WACC for the purpose of assessing excess profits. Subsequent sections estimate the parameter values in this model, leading to WACC estimates that are presented in section 9. Section 10 compares the model and parameter values here with those recently favoured by Australian regulators. Section 11 examines other factors that might be incorporated into a WACC estimate. Section 12 examines the process by which a WACC estimate is used to assess excess profits. Finally, in section 13, the estimation of WACC is reassessed in the context of setting a price cap.

2. The Choice of Model

This section presents a model for estimating the WACC for lines businesses, in the context of assessing excess profits. This exercise is similar to that conducted for the airfield operations of New Zealand's international airports and gas pipeline businesses (Commerce Commission, 2002a, 2004b), and the same model is employed here. In particular, the cost of capital is a weighted average of the costs of debt and equity, with the cost of debt net of the corporate tax deduction for interest, 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. In addition, k_d is 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, this is 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. The value for the tax parameter T_I is set at .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 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 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), have 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

[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%).

(Lally, 2000; Lally and Marsden, 2004a). 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 (2004a), 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 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.

Bowman (2005) also opposes equation (3) but he does not articulate any alternative.

3. The Market Risk Premium

3.1 Alternative Methodologies

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

[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 raise 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 an increase of less than .05%.

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. The third approach (Credit Suisse First Boston, 1998) invoked the methodology of Merton (1980), and generated an estimate of .073. 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; 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 requires adjustments to the above results and offers estimates from a number of other approaches. The full set of results is as follows. I start with New Zealand data and the Ibbotson methodology. This involves observation of the ex-post counterpart to the market risk premium in each year, followed by simple averaging of those outcomes over a long period. Lally and Marsden (2004a) have implemented this approach, using New Zealand data over the period 1931-2002, and obtain an estimate of .073. Marsden (2005) extends the data series to 1931-2004, and this raises the estimate to .077[4]. This estimate is obtained using a long-term risk free rate (around ten years), and is consistent with the taxation assumptions reflected in equation (4). An alternative estimate is that of PwC (2002), using data from 1925, and yielding a figure of .075. However, the current value for T_I that is invoked differs from that in equation (4), and correction for that would raise their estimate for the market risk premium in (4) to .078. They also define their market risk premium relative to one year bonds, and this complicates comparison with the other results offered here[5]. Finally, they assume that the relevant ordinary personal tax rate is simply the top statutory rate for

[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).

[4] The standard deviation on this estimate is .027, comprising the standard deviation of the annual outcomes of .235 (Marsden, 2005, p 20) divided by the square root of the number of years (74).

[5] I am unable to quantify the effect of this.

each year, whereas Lally and Marsden (2004a) estimate the average tax rate for each year, and find them to be typically well below the maximum rate. For these reasons, the results from Lally and Marsden (2004a), subject to the extension by Marsden (2005), are preferred.

The second approach is that of Siegel (1992). Siegel analyses real bond and equity returns in the US over the sub-periods 1802-1870, 1871-1925 and 1926-1990. He shows that the Ibbotson type estimate of the standard MRP is unusually high using data from 1926-1990, due to the very low real returns on bonds in that period. He further argues that the latter is attributable to pronounced unanticipated inflation in that period. 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 back the historical average long-term real risk free rate and then deducting an improved estimate of the expected long-term real risk free rate. Siegel suggests a figure of .03-.04 for the expected US long-term real risk free rate, and this is consistent with New Zealand data. Applying this approach to New Zealand data, Lally and Marsden (2004b) obtain an estimate for the tax-adjusted market risk premium of .055-.062, using data from 1931-2002. Correcting these numbers, for consistency with the tax assumptions of equation (4), the result is .056-.063. Marsden (2005) extends the data series to 1931-2004, and this raises the estimate to .060-.068[6].

The third approach is that of Merton (1980), who expresses the market risk premium as proportional to market volatility (variance or standard deviation), estimates the coefficient of proportionality, and then applies this to a current estimate of market volatility. Applying this methodology, with volatility defined as standard deviation and forecast over the next 15 years, Credit Suisse First Boston (1998) obtained an estimate of the market risk premium of .073. Furthermore, the estimates over the preceding few years were similar to this. However, these estimates do not reflect the taxation assumptions of equation (4), most particularly in using a value for T_I of .20

[6] This estimate represents the historical average equity return less an estimate for the expected long-term real risk free rate. The first term here is amenable to estimation of a standard deviation but the latter is not. Nevertheless, uncertainty in the latter is reflected in the range of estimates. The standard deviation on the former is about .028; this comprises the standard deviation of the annual returns of .24 (Marsden, 2005, p 17) divided by the square root of the number of years (74).

rather than .33[7]. 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 .081. More recently, Boyle (2005) has used this Merton methodology to estimate the market risk premium in the standard CAPM, for each year in the period 1970-2003. Volatility is defined as variance and is simply estimated from the preceding three years of data. The resulting estimates for the market risk premium vary from .009 to .336, due to variation in the estimates for variance. For consistency with the definition of the market risk premium in (4), one would need to add .020 to Boyle's estimates of the market risk premium and therefore the estimates for (4) would range from .029 to .356. Such implausible variation in the market risk premium leads Boyle to conclude that this methodology cannot be relied upon. The source of the problem is the unreliable estimates of variance, and the use of only three years of data to do so contributes to that problem. Clearly the use of a very long period for estimating volatility would be inconsistent with the presumption of intertemporal variation in volatility that underlies this methodology. So there is a trade-off here in choosing the period for estimating volatility, and no clear basis for determining the optimal period. The Credit Suisse First Boston study faces similar conceptual difficulties in choosing to forecast volatility over a 15 year period. In addition to this conceptual difficulty, the results from the latter study are no longer current. In view of all this, the overall outcome from both considering and not considering their results will be determined.

The fourth approach is the forward-looking one, in which the discount rate on the market is found that is consistent with the current value of the market portfolio, the current dividend yield and forecasts of growth in dividends per share for existing companies. Insertion of this discount rate into equation (4), along with the current value for the risk free rate, then yields the estimate for the market risk premium in (4). The difficulty in this approach lies in the forecasts for growth in dividends per share. Cornell (1999, Ch 4) obtains the short run dividend growth forecasts from that of analysts' short-run forecasts of growth in earnings per share, whilst the long-run dividend growth forecast is bounded above by the forecast growth rate in GDP. Lally

[7] The figure of .20 rather than .33 arises primarily because the tax circumstances of foreign investors are recognised in deriving the figure of .20. I consider this to be inappropriate because it constitutes only partial acknowledgement of the existence of foreign investors, and such partial acknowledgement may drive the WACC in the opposite direction to that implied by a full acknowledgement of their existence. Accordingly, the partial acknowledgement may produce perverse results.

(2001b) applies this methodology to New Zealand, and obtains estimates for the market risk premium in (4) of .058-.079. 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 above estimates, then the range would be .054-.075. Because the long-run forecast of growth in GDP is an upper bound on long-run growth in dividends per share for existing companies, then these estimates of the market risk premium will be biased up[8]. Lally (2005a) provides a more recent estimate of .060, net of a deduction of .010 for the biases just noted. Other variants on the forward-looking approach have been applied in other markets, but not yet in New Zealand.

The fifth approach considered is that of survey evidence. Lally, Roush and van Zijl (2004) have recently surveyed relevant academics and members of the Institute of Finance Professionals in New Zealand ("practitioners"). To facilitate comparability in responses, participants were asked for their estimate of the market risk premium relative to the ten year risk free rate and in respect of the standard CAPM, i.e., $k_m - R_f$. The results were a median estimate amongst the academics of .055 and one of .07 for the practitioners. Converting this to an estimate of the market risk premium in equation (4), using the ten year government stock rate of .056 at the time of the survey (May 2003 average), yields estimates of .073 for academics and .088 for practitioners. However the results for at least the practitioners may be biased up due to some practitioners mistakenly supplying an estimate of the market risk premium in equation (4) rather than for the standard CAPM.

All of these results reflect the use of New Zealand data. However, there are some difficulties with this data. In particular, the risk free rate was controlled in the period before 1985. In the absence of these controls, the risk free rate would presumably have been higher and therefore the Ibbotson-type estimate of the market risk premium

[8] The long run growth rate in dividends per share of existing companies cannot exceed that for aggregate dividends in existing companies (due to net new share issues), which cannot exceed the long run growth rate for the aggregate dividends in all New Zealand companies (due to the creation of new companies), which cannot exceed the long run growth rate in GDP. Arnott and Ryan (2001) argue that the distinction between current companies and all companies alone subtracts 1-2% from the estimated growth rate, and therefore also in the estimate of the market risk premium. Bernstein and Arnott (2003) argue for subtracting 2% to deal with both this point and new share issues (net of buybacks).

would have been lower[9]. Although this problem afflicts only the Ibbotson estimate, in the event of seeking estimates from foreign markets, consistency would argue for seeking such estimates in respect of all approaches considered here. This further points towards seeking data from markets that can supply estimates of all such types. Accordingly, estimates from the US are sought, although results for a broader set of markets are also noted where they are available.

In respect of the Ibbotson approach, Dimson et al (2002, Table 33-1) generates an estimate of the standard market risk premium in the US, using data from 1900-2000, long-term bonds, and arithmetic differencing, of .069[10]. Converting this figure to an estimate of the market risk premium in equation (4), using the New Zealand ten year government stock rate of .061 (April 2005 average), yields an estimate of .089. Dimson et al (ibid) also offer estimates of the standard market risk premium for fifteen other foreign markets, mostly over the same 101 year period. The median result is .066[11]. Using the same conversion to equation (4), the result is .086.

In respect of the Siegel approach, this involves an adjustment to the Ibbotson estimate as previously discussed. Starting with the US, the Dimson et al (2002, Table 33-1) Ibbotson-type estimate is .069 and embodies a historical average long-term real risk free rate of .021. These numbers should be added, and from them deducted an improved estimate of the US long-term real risk free rate. An estimate of the latter is .03-.04[12]. The resulting Siegel-type estimate of the standard market risk premium for

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[9] The rate controls were accompanied by controls that compelled purchase of the bonds by selected entities. The latter controls prevented investors in aggregate from switching away from low yielding government bonds. Accordingly, there should have been no change in the expected return on equities. It follows that the downward effect upon the risk free rate induced an upward effect upon the estimated market risk premium if estimated using the Ibbotson methodology.

[10] The primary result presented by them uses geometric rather than arithmetic differencing of annual stock and bond returns, and is .070. However, geometric differencing is not consistent with the definition of the market risk premium. The result from arithmetic differencing was obtained by subtracting their average bond return from their average stock return. The standard deviation on the estimate is .020.

[11] The average of the standard deviations on these estimates is .022.

[12] One means of estimating this is the average yield on inflation-protected bonds. However these have only been available in the US since 1997 (data from the Federal Reserve Bank of St Louis website), and the average since then of .03 may not be indicative of the long-run situation. An alternative estimate is the average real return on conventional government bonds over a period in which inflation was stable and default risk was slight. The period 1871-1926 satisfies these requirements, and yields

the US is .05-.06[13]. Converting this figure to an estimate of the market risk premium in equation (4), using the New Zealand ten year government stock rate of .061 (April 2005 average), yields an estimate of .070-.080. Dimson et al (ibid) also offer Ibbotson type estimates and average real rates on government bonds for fifteen other foreign markets, mostly over the same 101 year period. This data is used to replicate the process for the US. Lacking an estimate of the expected long-term real risk free rates for each of these markets, I invoke the US estimate noted above of .03-.04. The median Siegel-type estimate for the standard market risk premium is then .041-.051[14]. Using the standard conversion to equation (4), the result is .061-.071.

In respect of the Merton approach, there is some difficulty in extrapolating any foreign results to the New Zealand market. In particular, it is explicit in the Merton approach that the market risk premium is proportional to market volatility, and the latter clearly varies over markets (Cavaglio et al, 2000, Table 1). In view of this, no results are offered.

In respect of Cornell's forward-looking approach, Cornell (1999, Ch. 4) obtains an estimate of .045 for the standard market risk premium in the US. Corrected for the difference in definitions of the market risk premium, using the New Zealand ten year risk free rate of .061 (April 2005 average), this implies an estimate for the market risk premium in equation (4) of .065. However this estimate does not contain any deduction for the biases discussed in footnote 8. Using the same deduction of .010 used by Lally (2005a), the resulting estimate for the market risk premium in (4) is .055.

Finally, in respect of survey evidence, Welch (2001, Table 2) surveys US academics and reports a median estimate of .050 defined relative to short-term bonds. At the time of the survey (August 2001), US ten year bonds were offering about .015 more

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an estimate of .04 (Siegel, 1992, Table 2). These two approaches suggest a long-run real risk free rate for the US of .03-.04.

[13] For each point in the range, the standard deviation is that for the average real return on equities, and this is .020.

[14] Following the previous footnote, the average standard deviation here is .023.

than short-term bonds[15]. So, measured relative to US ten year bonds, Welch's survey evidence implies a figure of about .035. Corrected for the difference in definitions of the market risk premium, using a New Zealand ten year risk free rate of .061 (April 2005 average), this implies an estimate for the market risk premium in equation (4) of .055. In addition, Graham and Harvey (2005, Table 1) survey US CFOs and report a median estimate of .036 defined relative to ten year bond yields[16]. Corrected for the difference in definitions, this implies a estimate for the market risk premium in equation (4) of .056.

3.2 Conclusions

To summarise the results in the previous section, the New Zealand results are .077 for the Ibbotson approach (standard deviation .027), .060-.068 for the Siegel approach (standard deviation for each point in the range is .028), .081 from the Merton approach, .060 for Cornell's forward-looking approach, and .073 (.088) from survey evidence from academics (practitioners). The corresponding US results are .089 from the Ibbotson approach (standard deviation .020), .070-.080 from the Siegel approach (standard deviation for each point in the range is .020), .055 from Cornell's forward-looking approach, and .055 (.056) from survey evidence from academics (practitioners). In respect of other foreign markets the results are .086 for the Ibbotson approach (average standard deviation .022) and .061-.071 for the Siegel approach (average standard deviation for each point in the range is .023). Using mid-points in the case of range data, and forming a simple average of the survey results for each of New Zealand and the US, the point estimates are shown in Table 1 below (with standard deviations in brackets). Across the entire set of results, the range is .055 to .089 with a median of .075. Deletion of the results from the Merton methodology, for the reasons discussed earlier, reduces the median from .075 to .070. For those approaches amenable to estimation of a standard deviation on the estimate, the estimated standard deviations range from .020 to .028.

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[15] This data is drawn from the website of the Federal Reserve.

[16] Their Table 1 reports results for a series of surveys over time, with median estimates ranging from .029 to .045. The median of this set is .036.

Table 1: Estimates of the Market Risk Premium

	NZ	US	Other
Cornell Methodology	.060	.055	
Siegel Methodology	.064 (.028)	.075 (.020)	.066 (.023)
Ibbotson Methodology	.077 (.027)	.089 (.020)	.086 (.022)
Survey Results	.080	.055	
Merton Methodology	.081		
Median	.077	.065	.076

All of these figures invoke the ten year risk free rate. This should reflect the investor horizon in the context of the CAPM, but it not apparent what this horizon is. If the five year rate was used instead then, on the basis of the April 2005 differential between New Zealand five and ten year bond yields (the former rate is larger by .001), the New Zealand estimates of the market risk premium would fall by .001[17]. Applying the same process, the US estimates would rise by .004, and this is extrapolated to the other foreign markets[18]. The median over the entire set of results would then rise marginally from .075 to .076 (or from .070 to .073 if the results from the Merton methodology were disregarded). Such adjustments are only indicative in view of the inability to adjust most of the estimates. In view of this data limitation, and the uncertainty surrounding the correct investor horizon, I favour use of the estimates based on the ten year risk free rates.

The appropriate weightings for the three sets of estimates in Table 1 are debatable. The New Zealand estimates span a wider range of methodologies, although the Ibbotson-type estimate is subject to the pre 1985 data problems referred to earlier. The US estimates are less relevant because some of the underlying variables that drive

[17] Such a correction will only be appropriate for the forward-looking and survey methods. I am unable to adjust the results for the other methods.

[18] Use of the five year rate lowers the rate by .006 (December 2004 mean: data from the website of the Federal Reserve Bank of St Louis), yielding an increase of .004 to the estimate of the market risk premium.

market risk premiums differ across the two markets. For example, US market volatility is lower, and this should induce a lower market risk premium. On the other hand, US equity returns may be subject to higher personal taxes, due to the absence of dividend imputation and the imposition of capital gains taxes on most investors; the effect of this would be to raise the required return on equity, and therefore raise the market risk premium. Finally, in respect of the other foreign estimates, they enjoy some protection from the US problem just noted because they reflect a wide range of markets. However, they offer results for only two of the approaches applied to New Zealand. On balance, this suggests that greater weight be applied to the New Zealand estimates, although the practical effect is slight because the median estimate for New Zealand is similar to that of the aggregate results (.077 versus .075 with inclusion of the results from the Merton methodology and .070 in both cases with exclusion of the results from the Merton methodology).

All of the above methods assume that there is no evasion or avoidance of taxation, but allowance for such will only slightly affect the estimates[19]. Other considerations point to the estimates in Table 1 being too high, as follows. Firstly, Ibbotson-type estimates are in general liable to be biased up because market risk premiums are likely to have declined over time as a result of reductions in market volatility[20]. Secondly, the New Zealand Ibbotson-type results are likely to be further biased up due to interest rate controls before 1985. Thirdly, the New Zealand practitioner survey results may be too high for reasons indicated earlier. Finally, the set of estimates provided omits results from foreign markets for which comparable New Zealand results are not available. In particular, there are a number of forward-looking estimates for foreign markets involving approaches other than that of Cornell (1999), and the results are generally lower than that of Cornell. In respect of the US, for which Cornell obtained .045, these other approaches include Fama and French (2002), who obtain .026-.043 (defined against short term bonds, implying less than this

[19] The assumption of no evasion or avoidance is implicit in basing the estimate of T_I on tax paid and reported income rather than tax paid and taxable income. Evasion and avoidance reduces both tax paid and reported income, and is therefore essentially not detected through this approach to estimating T_I. The effect of lowering the effective tax rate is discussed in footnote 2, and shown there to be slight.

[20] In addition to the theoretical linkage between the market risk premium and market volatility, further evidence for declines in the former lies in the rise in P/E ratios over time. Both of the principal providers of Ibbotson-type estimates have alluded to this evidence in support of the conclusion here (Dimson et al, 2004; Ibbotson and Chen, 2003).

against long-term bonds), Claus and Thomas (2001), who obtain .034, and Jagannathan et al (2001), who obtain .013. The last three figures require addition of .020 to generate estimates of the market risk premium in equation (4), yielding estimates of .046-.063, .054 and .033.

Taking account of all this, I favour an estimate of .07. This point estimate corresponds to that recently offered in respect of the gas pipeline businesses (Lally, 2004b), and contrasts with the estimate of .08 offered earlier in respect of airfield activities (Lally, 2001a). The latter difference is attributable to additional results becoming available in the intervening period.

To formalise my confidence in the point estimate of .07, I estimate the standard deviation for this. In doing so, I draw upon the standard deviations of the individual estimates in Table 1 along with the fact that the estimate proposed here is effectively a weighted average over those individual estimates. The act of forming a weighted average over a range of individual estimates will produce a standard deviation on the weighted average estimate that is considerably less than the average standard deviation on the individual estimates. To illustrate this point, following Lally (2005b), suppose that the estimate is based on the individual estimators X_1 and X_2, with standard deviations of .023 each (the average figure in Table 1) and these estimators are independent[21]. In this event, the optimal estimator places equal weight upon X_1 and X_2, and the standard deviation of the equally weighted estimator is .016 as follows.

$$\begin{aligned}\sigma(.5X_1 + .5X_2) &= \sqrt{Var(.5X_1 + .5X_2)} \\ &= \sqrt{.25Var(X_1) + .25Var(X_2)} \\ &= \sqrt{.25(.023^2) + .25(.023^2)} \\ &= .016\end{aligned}$$

Thus, the act of drawing upon two (independent) estimators reduces the standard deviation by 30%. In the presence of more than two individual estimators, the gains

[21] If the two estimators were the Ibbotson and Cornell estimators, independence would exist on account of the former using only historical data whilst the latter used current and forecast data.

here will be even greater. Taking account of this principle, and the standard deviations reported in Table 2, points to a standard deviation on the overall estimate of about .015[22].

The above point 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, the Ibbotson, Siegel and Merton approaches are not particularly sensitive to re-estimation of the parameter a few years earlier. In respect of the forward-looking and survey approaches, these are not in general available at earlier points in time. All of this suggests that the estimate for the market risk premium should *not* be adjusted when the WACC is estimated for earlier years.

3.3 Contrary Views

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 (2004a). In fact, as indicated above, the figure of .070 is based upon a consideration of the results from eleven distinct approaches. Emanuel (ibid) also favourably cites the figure of .094 appearing in the Airfields Report (Lally, 2001a), being the result from applying the Ibbotson methodology to a number of foreign markets. However the (updated) results from this methodology are part of the set of results underlying my conclusion of .070.

Emanuel (2003b) also argues for a standard deviation on the estimate for the market risk premium of .028, based on the results from historical averaging methodology (see Table 1). This contrasts with my estimate of .015. Emanuel's suggestion assumes that the market risk premium has been estimated exclusively by the historical

[22] A band involving one standard deviation around the point estimate is therefore .055-.085. If the distribution is normal, such a band corresponds to 68% of the subjective probability distribution, i.e., there is one chance in six of the true value lying below .055 and one chance in six of it exceeding .085. In addition, the band involving two standard deviations would range from .04-.10, and this embraces 95% of the subjective probability distribution. Thus, I am virtually certain that the true value lies within this range.

averaging methodology. This is not the case. It has been estimated by considering the results from eleven 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 (2003a), 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 Marsden (2005) figure of .077, it would not affect the average of the results across the eleven approaches examined and therefore would not change the conclusion of .070.

PwC (2003d) also examine six of the approaches considered by me, and suggest some modifications to some of the results, thereby generating an average across the six approaches of .076[23]. However this latter figure reflects results from only six of the eleven approaches that are now considered. Furthermore, I do not concur with the adjustments undertaken by PwC, of which the two most significant are as follows. First, PwC raises the Welch (2001) survey result 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. Secondly, and in respect of the analysis in Lally and Marsden (2004a) and Marsden (2005), PwC argue that the applicable marginal tax rate on ordinary income for (equity) investors is equal to the top statutory rate rather than the "median" rate used in these studies, and claim that this would raise the Ibbotson type estimate in these studies by .014.

[23] The six approaches examined are those reviewed in an earlier version of this report.

However, as discussed in Lally and Marsden (2004a), the applicable rate is a weighted average and the median rate is a proxy for this[24].

NECG (2003a) argue for a market risk premium of .10[25]. 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 risk 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. In support of the increment of .03 for the country risk difference, NECG argues (inter alia) that a reasonable methodology would be to consider the New Zealand market as part of the US market, that the average beta of New Zealand firms against the US market would be 1.25-1.5, and that this leads to an increment of .03.

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[26]. 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. A

[24] Lally and Marsden (2004a) do nevertheless accept an earlier criticism in PwC (2003b), that the relevant set of investors are those holding shares rather than shares and bonds. Recognition of this point raised their estimate for the market risk premium from .071 to .073. Marsden's (2005) estimate of .077 also recognises this point.

[25] 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.

[26] 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.

further difficulty lies in their argument for the country risk adjustment of .03**.** Such a process would be appropriate if an international version of the CAPM applied, along with the use of the US market as a proxy for the world market portfolio, and is consistent with NECG's beliefs concerning integration of markets. However, no empirical evidence is offered here in support of the beta figures of 1.25-1.5. In a further submission, NECG (2004b) reports the results of regressing the NZSE against the US market over the period 1988-2002, and the figure is 0.48 rather than 1.25-1.5. In the context of an international CAPM, this implies that the market risk premium for New Zealand would be *less* than the US rather than greater, and this point is discussed in detail in section 9.2. Thus, NECG's (2004b) own analysis undercuts their argument for an increment of .030.

Bowman (2005) follows the same approach, differing from NECG only in invoking an estimate for the US of .055 defined relative to long-term bonds[27]. With the same country risk adjustment of .03, and addition of a further .02 to reflect the conversion to the market risk premium in equation (4), his point estimate is .105 rather than .10. This approach suffers from all of the same difficulties as NECG's[28].

NECG (2003a) also argue that the estimate of .07 for New Zealand is inconsistent with the widely used estimate of .06 in Australia. Proper comparison requires two adjustments in their view. First, the figure of .07 must be reduced by .02 to yield an estimate for the market risk premium in the standard CAPM (of .05). Secondly, the Australian figure of .06 is based on a long term risk free rate and must be raised by .01 to reflect the short term risk free rate used in Lally and Marsden (2004a). Thus, with these adjustments, the New Zealand figure is .02 *smaller* than the widely used Australian figure, and this is implausible. Bowman (2005) reiterates the need for the first of these adjustments.

I concur with the widely used Australian figure of .06 (Lally, 2002a, 2004d) and with

[27] Bowman was the author of the NECG reports, and therefore the similarity in approach is unsurprising.

[28] It should be noted that, despite this line of argument being presented in his section 3.7, Bowman offers a point estimate of .08 at the beginning of that section, in section 3.9 and in his Executive Summary.

the view that the New Zealand market risk premium should be approximately equal to that for Australia[29]. However, there are two errors in NECG's adjustments. First, all of the numbers used by me in arriving at an estimate of .07 for the market risk premium in equation (4) are based on 10 year risk free rates, and are therefore comparable with the Australian number, i.e., no adjustment is required for the term of the risk free rates. Second, the widely used Australian figure of .06 is an estimate of the market risk premium in the Officer (1994) version of the CAPM rather than the standard CAPM. This model differs from the standard CAPM in including imputation credits (to the extent of being usable) within the definition of dividends, and therefore in the definition of the market return, i.e., the market risk premium in the Officer model is

$$\hat{k}_m - R_f = k_m - R_f + UD_m \frac{IC_m}{DIV_m}$$

where U is the utilisation rate for imputation credits, D_m the market cash dividend yield and IC_m/DIV_m the ratio of imputation credits to dividends for the market portfolio. Within the New Zealand market, empirical estimates for the last two parameters are .04 and .40 (Lally, 2000, p 6). In addition, in the context of a domestic version of the CAPM (in which markets are assumed to be fully segregated), an appropriate estimate for U is 1. Thus, an estimate of .06 for the market risk premium in the Officer model implies an estimate of .046 for the standard CAPM. In turn, this implies an estimate for the market risk premium in (4) of .066. So, with appropriate corrections, the figure of .07 recommended here is *larger* by .004 than the widely used Australian figure of .06 for the Officer model rather than being *smaller* by .02.

In respect of the standard deviation on the point estimate, Bowman (2005) favours an estimate of at least .03 rather than the estimate of .015 favoured by me. However, Bowman's point estimate appears to be largely based on the results of one methodology (Ibbotson). By contrast, the point estimate favoured by me draws upon the results from eleven approaches. As discussed in the previous section, recourse to

[29] 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 10.

such a wide variety of approaches induces a significant reduction in the standard deviation on the overall point estimate.

LECG (2003a) 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. In a subsequent paper (LECG, 2003b) they lower their estimate of the US market risk premium to .064, and therefore that for New Zealand in equation (4) to .085.

The difficulty with this argument is the *exclusive* reliance upon one estimation methodology (Ibbotson). In my view all approaches to estimation are imperfect, and this argues for considering all of them. Furthermore, as discussed in the previous section, Ibbotson-type estimates are likely to be biased up. Finally, and even leaving aside the New Zealand data that I have drawn upon, most US studies generate significantly lower estimates of the market risk premium (defined against long-term bonds) than the .064 figure favoured by LECG (2003a, 2003b). These studies include Cornell (1999, Chapter 4), who obtains .045, 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 .035 (defined against long-term bonds, as derived earlier). LECG give no weight to these results. Furthermore, the use of their estimate of .064 for the US presumes that there are no cross-country differences in market risk premiums or that these differences wash out over a large set of markets, i.e., New Zealand is typical. The first possibility is untenable and the second is unproven.

In a further submission, LECG (2003c) observe (correctly) that all of the above estimates for the market risk premium are generated independently of the CAPM, i.e., none of them is a consequence of the CAPM. LECG then presents two estimation methods that derive from the CAPM. The first of these arises from the fact that the market risk premium in the single-period version of the CAPM is proportional to market variance, i.e.,

$$MRP = \lambda Var(R_m) \tag{6}$$

where λ is the average investor's coefficient of relative risk aversion. With an estimate for market variance of .06 (based on New Zealand data for the last 50 years), and an estimate for λ of 5, the resulting estimate of the market risk premium is about .30. The second estimation method arises from the fact that the market risk premium in the "consumption CAPM" (Breeden, 1979) is proportional to the covariance between aggregate consumption C and market return, i.e.,

$$MRP = \lambda Cov(C, R_m) \tag{7}$$

LECG estimate this covariance using New Zealand data over the last 50 years at .002. In conjunction with the previously noted estimate for λ of 5, the resulting estimate of the market risk premium is about .01. LECG argue that these two estimates are at least as reliable as those obtained earlier, on the grounds of being based on relationships that are implied by the CAPM. Nevertheless, these two estimates are vastly different and lead LECG to conclude that there must then be considerable uncertainty about the true value of the market risk premium. Accordingly, it seems prudent to allow a wide range for the parameter. LECG do not indicate how wide this range should be, but they imply that the standard deviation is larger than my estimate of .015.

There are a number of difficulties with this line of argument. First, equation (7) is associated with the "consumption CAPM" rather than the single period model that is used in this paper. It could be argued that the single period model is merely a special case of the consumption CAPM (under certain conditions), and therefore (7) must also characterise the single period model. However it is not apparent that these conditions are realised, and the fact that estimates from equation (7) are implausibly low is consistent with that[30]. An alternative view is that the single period model is a distinct model rather than a special case of the consumption CAPM, in which case (7) is irrelevant to it.

Second, and in respect of equation (6), the two parameter estimates underlying the figure of .30 presented by LECG are arguable[31]. In respect of their estimate for the market variance of .06, this accords with results in Lally and Marsden (2004a, Table 2) using data for the period 1931-2002. However, use of data from the more recent period 1985-2000 produces the significantly lower figure of .04 (Cavaglio et al, 2000, Table 1). In addition, and using data over the period 1968-1997 to implement a similar model to that of (6), Credit Suisse First Boston (1998) generate an average estimate of .022 with a resulting estimate for the market risk premium of .081[32]. In respect of the parameter λ, LECG's estimate of 5 is claimed to be a typical figure. By contrast, Mehra (2003, p 59) suggests that a typical figure is 2, and this accords with the empirical estimates in Harvey (1991, Table VIII) for 17 countries over the period 1970-1990, and also with Merton's (1980, Tables 4.1, 4.2, 4.3) estimates for the US using data from 1926-1978. Furthermore, Boyle (2005) subsequently estimates λ at 1.4 for New Zealand[33]. Using an estimate for the market variance of .04 and an estimate for λ of 2, the market risk premium would then fall from LECG's figure of .30 to .08, which is similar to the estimate recommended in the present paper. Thus, if equation (6) were employed, it would appear to admit a wide range of possible results. So, rather than dramatically expanding the range of feasible estimates for the market risk premium, this suggests to me that results from equation (6) should be treated with great caution; this is consistent with the earlier analysis in this paper and the views expressed by Boyle (2005). Furthermore, Lally (2005b) shows that estimators with

[30] Conditions under which the single-period model arises in this way include the world being only one period in nature and reinvestment opportunities not altering over time. However, the world is multi-period in nature and reinvestment opportunities do change over time (particularly the risk free rate).

[31] They also relate to the standard version of the CAPM rather than to the tax-adjusted version invoked in this paper. However, this point is secondary in the sense that a figure of .30 for the standard version would imply an even larger figure for the tax-adjusted version.

[32] This work was discussed in the previous section. The underlying model differs from (6) in assuming that the market risk premium is proportional to market standard deviation rather than variance. Merton (1980) presents and estimates both models.

[33] Boyle was the author of the LECG (2003c) paper referred to above.

high variability warrant lower weight, and this strengthens the argument for treating results from equation (6) very cautiously.

Finally, whilst equation (6) gives rise to a wide range of possible estimates, values as large as .30 cannot be reconciled with past average returns or market dividends, and this argues for even more caution in drawing upon equation (6). In respect of past average returns, Marsden (2005) present an estimate based on this of .077 with a standard error on it of .027. A figure of .30 is then over eight standard errors away. In respect of market dividends, and considering the methodology of Cornell (1999) discussed earlier, a market risk premium of .30 along with the current dividend yield of about .04 and a risk free rate of .05 would require a long-run expected growth rate in dividends per share of about .30 per annum, and therefore a long-run expected growth rate in GDP of more than .30 per annum. This is simply inconceivable.

In summary, I do not consider that the arguments in these submissions warrant an change in the estimate of .070 for the market risk premium in equation (4) or the standard deviation around that point estimate of .015.

4. 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 assessment of excess profits from 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 preceding month. NECG (2003b) argue for using the rate on the commencement date, 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 review period suggests that the appropriate term for the risk free rate is that matching the review period. However, as shown in Lally (2002b, 2004a), 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 (future) period over which excess profits will be assessed.

That the choice of the risk free rate should be governed by the frequency with which prices are reset rather than in some other way 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. 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 now using the ten year rate (for example), 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 them.

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, and any forward-looking assessment of excess profits by the Commission will not change this. The feasible candidates for the price-resetting frequency are in the 1-5 year range, and I favour 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)[34]. Since forecast excess profits are examined, and future interest rates are indeterminable, one is bound to act as if they will not change. So, the current three year risk free rate should be employed throughout the entire future period subject to the assessment.

[34] This assumes that firms coincidentally revise their prices at the commencement of any review period. Of course, this will not generally be the case. If, for example, firms revised their prices one year before the beginning of the review period, the appropriate risk free rate would be that set one year before the beginning of the review period. Since information of this type is not readily available, and there will in any case be variation across firms, a pragmatic solution is to simply invoke the risk free rate at the commencement of the review period.

A number of submissions (Dunedin Electricity, 2003; PowerNet, 2003) have argued that the risk free rate, and therefore 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 (2002b, 2004a). 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, 2003a, 2003b; Bowman, 2005). 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, 2002b, 2004a). 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 (2002b), 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 (2004a) shows that recognition of such risks has no effect upon the conclusion.

LECG (2003b) also argue that the use of a short-term risk free rate is likely to induce volatility into the firm's cash flows. However such a comment does not address the present value argument. Furthermore, if firms reset output prices every (say) three years, they can be presumed to recognise prevailing interest rates in doing so, i.e., their revenues reflect the three year risk free rate. Accordingly, the use of a three year risk free rate in assessing excess profits matches the cost of capital to the firm's revenues, and therefore *removes* rather than introduces interest rate risk.

In a variant of the argument concerning matching the risk free rate term to the life of the firm's assets, Bowman (2005) and NERA (2004) focus upon debt finance and argue that firms will choose debt maturities to match the life of their assets rather than the price-resetting cycle. Accordingly, the risk free rate used in assessing the WACC should match the term of this debt. However, the assessment of the risk free rate in this way, with revision at the end of the price-resetting cycle, would violate the present value principle noted above. It would also manifest itself in the form of interest rate risk to the firm, i.e., its cost of debt is set for long periods but output prices are reset more frequently to, inter alia, reflect prevailing interest rates. NERA (2005) claims that use of the ten year rate is more likely to satisfy the NPV test, but they offer no proof of this claim.

Bowman (2005) also argues, in the presence of debt, that there is a "re-contracting" risk upon the maturity of the debt and recognition of this undermines the Present Value argument. However, Bowman offers no analysis in support of the assertion nor does he demonstrate that matching the risk free rate to the life of the firm's assets would satisfy the Present Value test.

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, i.e., consistency should apply (LECG, 2003a; MEUG, 2003a; Bowman, 2005). This consistency argument would appear to be confirmed by considering the case when beta equals one. In this event the cost of equity must coincide with the expected return on the market portfolio E_m. To simplify the presentation, assume that the tax parameter $T_I = 0$, the price resetting cycle is one year and the risk free rate used in estimating the market risk premium is the two year rate R_{f2}. Following the argument presented here, the risk free rate used as the first term in equation (3) should be the one year rate R_{f1}. The cost of equity would then be

$$k_e = R_{f1} + E_m - R_{f2} \tag{8}$$

and this appears to diverge from E_m whenever R_{f1} diverges from R_{f2}. The essential difficulty in this area is that the CAPM generates a cost of equity for only one future period, coinciding with the investor horizon. In this example, this future period is assumed to be two years. In this event, the CAPM cannot specify the cost of equity for the price resetting cycle of one year. The choice then lies between discarding the model and adapting it to the situation in question. The former possibility can be dismissed for lack of an alternative model, leaving us with the need to adapt the model to a one year period. In seeking to adapt it, the first term in the model must be the risk free rate for the price resetting cycle, so as to ensure that the correct cost of equity results as beta goes to zero (the correct rate in this case is R_{f1} to ensure that the present value of the future cash flows matches the initial investment). Having said this, consideration of the case when beta equals one seems to argue for consistency, and therefore for also using the rate R_{f1} in estimating the market risk premium. However, as discussed in section 3.2, data limitations point to the use of the ten year risk free rate in estimating the market risk premium. Furthermore, even in the absence of data limitations, the consistency argument is not compelling. It rests on the assumption that the expected market return E_m is the same for all future periods, and this appears to conflict with the fact that R_{f1} differs from R_{f2}. Differences in the latter two rates may be due to the expectations hypothesis, i.e., to the expectation that the one year risk free rate in one year will differ from the current one year rate. For example, if R_{f1} = .05 and R_{f2} = .06, this implies a market belief that the one year risk free rate in one year will be .07. Accordingly, the value for E_m over the next year (E_{m1}) may differ from the annualised value applicable to the next two years (E_{m2}). With a two year horizon implicit in the model, equation (8) then becomes

$$k_e = R_{f1} + E_{m2} - R_{f2}$$

To assess whether this yields a cost of equity equal to E_{m1}, one must make some assumption about the "term structure" for the market risk premium. For example, if one is prepared to assume that $E_{m2} - R_{f2} = E_{m1} - R_{f1}$ then the last equation reduces to

$$k_e = R_{f1} + E_{m1} - R_{f1} = E_{m1}$$

and the apparent error in (8) then evaporates. Elimination of the apparent error requires that the expectations hypothesis fully describes the term structure of interest rates, and the empirical evidence is otherwise. Nevertheless, the consistency argument presented here requires that E_m is invariant to the choice of the future period, even in the face of R_{f1} differing from R_{f2}, and this is untenable. So, the consistency argument is flawed.

Bowman (2005), LECG (2004) and NERA (2004) argue that consistency is mandated by use of the CAPM, i.e., using different risk free rates is not the CAPM. If this single risk free rate were matched to the life of the assets in question then, in view of the fact that this life will vary over projects, the estimated market risk premium will also vary over projects. Such variation is also incompatible with the CAPM. So, whatever course of action is taken will lead to conflict with the CAPM. The choice is not between theoretical perfection and imperfection but with a number of theoretically imperfect solutions, simply because the CAPM is insufficiently flexible to accommodate all possible situations.

In summary, a theoretically satisfactory application of the CAPM is not possible and some adaptation of the model is unavoidable. In the face of various alternative adaptations, the present value principle is paramount, i.e., the present value of future cash flows should match the initial investment. This principle leads to the conclusion that the first term in the CAPM (R_{f1}) must match the price-setting period, assumed to be three years. This leaves the question of which risk free rate term should be used in estimating the market risk premium (R_{f2}), and the problem of data availability leads to use of the ten year rate here. So, R_{f1} is the three year rate and R_{f2} is the ten year rate. The principal contrary arguments here are that R_{f1} should match the life of the assets, and that R_{f1} should match R_{f2} (and the latter should be the 10 year rate on account of data availability problems). Both arguments violate the present value principle. Furthermore, the argument for matching R_{f1} and R_{f2} has the further drawback of implying a flat term structure for E_m even when the term structure for R_f is otherwise.

5. The Asset Beta

5.1 Underlying Factors

The asset beta of firm *j* is defined as the covariance between the unlevered return on the firm (R_j) and that of the market (R_m), divided by the variance of the latter, i.e.,

$$\beta_j = \frac{Cov(R_j, R_m)}{Var(R_m)} \tag{9}$$

Although beta arises within the CAPM, the model itself has nothing to say about how returns are formed. However Arbitrage Pricing Theory (Ross, 1976) models returns on assets as a linear function of certain macro-economic shocks (F_1, F_2……F_k) and a residual attributable to firm specific events (e_j), i.e.,

$$R_j = a_j + b_{1j}F_1 + b_{2j}F_2 + \dots\dots\dots + b_{kj}F_k + e_j \tag{10}$$

where b_{1j}, b_{2j}……b_{jk} are the sensitivities of R_j to these common shocks. If these macro-economic shocks are defined to be independent of one another, then substitution of (10) into (9) reveals the following (Dybvig and Ross, 1985)

$$\beta_j = b_{1j}\left[\frac{Cov(F_1, R_m)}{Var(R_m)}\right] + \dots\dots\dots\dots\dots + b_{kj}\left[\frac{Cov(F_k, R_m)}{Var(R_m)}\right] \tag{11}$$

So the beta of asset *j* is a linear function of its sensitivity coefficients b_{1j}….b_{kj}. Since the terms [ ] in equation (11) are identical across assets, then differences in asset betas must arise from differences in the sensitivity coefficients. Chen, Roll and Ross (1986) suggest that these common shocks are unexpected changes in real GNP, inflation, market risk aversion and the long-term real interest rate. Amongst equities, the chief source of variation in betas should be in the sensitivities of asset returns to real GNP. The sensitivity to inflation and the long-term real interest rate should be similar[35], whilst the sensitivity to market risk aversion should essentially reproduce that for real GNP[36].

The sensitivity of unlevered returns to real GNP shocks will be driven by a number of underlying factors. 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[37]. Rosenberg and Guy (1976, Table 2) document

[35] By contrast bonds will have sensitivities to inflation and real interest rate shocks which vary significantly according to their term to maturity (Cornell and Green, 1991).

[36] Changes in market risk aversion should lead to changes in the market risk premium, and the effect on asset returns will depend upon betas.

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

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, although this has no implications for the lines businesses[38]. 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[39].

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. However 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

[38] 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.

[39] This is because personal demand for electricity involves demand for an "essential" product. By contrast, business demand for electricity constitutes intermediate demand, whose sensitivity to GNP shocks will be driven by the sensitivity of consumers' demands for the final products in question. The situation is reversed in the case of air travel, where the personal demand for it would have greater sensitivity to GNP shocks than business demand, because personal consumption of it is a luxury.

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[40]. 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 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 cost 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 (2002c) 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 cycle. Given that firms subject to rate of return regulation should have very low betas (lower than otherwise identical unregulated firms) and beta increases with the reset interval, then firms with short (long) reset intervals should have lower (higher) asset betas than otherwise identical unregulated firms. The explanation is as follows, and is implied by the discussion in the previous paragraph relating to the duration of contract prices. In particular, for short reset intervals, the greater exposure to cost shocks arising from the regulatory process (this raises beta) is dominated by the lower exposure to demand shocks arising from the regulatory process (this lowers beta); for long reset intervals, the greater exposure to cost shocks dominates the lower exposure to demand shocks. In respect of the lines businesses, there are no price controls in force. However price and quality thresholds apply and breaches of them

[40] 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.

may lead to the Commission conducting an assessment of excess profits. These circumstances are likely to affect the behaviour of the lines businesses.

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 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[41].

The seventh factor is the extent of the firm's real options, most particularly the option to adopt new products ("growth" options). 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 "growth" options.

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

The eighth factor is operating leverage. If firms have linear production functions and demand for their output is the only random variable (i.e., monopoly power), 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 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[42]. Consequently this point is not significant.

5.2 Estimates

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

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

respect of the lines businesses themselves, only one of them is listed (Horizon Energy) whilst a second (PowerCo) recently ceased trading and a third (United Networks) was traded until the end of 2002 (at which point the assets were split between PowerCo and Vector). 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 – Dec 2002 yields the results shown in Table 2 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[43]. The debt/equity levels for each firm, for each of these three years and the average, are shown in Table 2[44]. Substitution of these estimated equity betas and average debt/equity levels into equation (5) then yields the asset betas indicated in Table 2, with a median of .19. Given the small number of companies, no great reliance can be placed on this median result of .19.

Table 2: Asset Beta Estimates for New Zealand Electricity Lines Businesses

		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
Median						.19

[43] 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.

[44] 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).

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 US electric utilities, which are subject to rate of return regulation with annual resetting of prices. This set of firms is augmented by US firms in the gas distribution sector, on two grounds. Firstly, the two sets of US firms appear to be similar. Secondly, the asset betas of New Zealand gas pipeline businesses have also been assessed. Consistent treatment of the two sets of New Zealand firms suggests that both draw upon the same pool of US firms. Thus, asset beta estimates for US electric utilities and gas distribution firms are jointly used to infer asset betas for the New Zealand lines businesses and gas pipeline businesses.

Damodaran (2004) presents estimated equity betas for 64 US electric utilities (SIC codes 4911-4913) and 29 gas distribution firms (SIC code 4920)[45]. The book value of debt and the market value of equity are also presented. Using this data, estimated asset betas are generated for each of the firms, using the Hamada (1972) formula with a company tax rate of .34. The result is an average of .35 for the electric utilities and .17 for the gas distribution firms, with an overall average of .29. However these average asset betas reflect market leverage and the tax environment in the US rather than for New Zealand. The adjustment formula is detailed in Lally (2002c), and requires knowledge of market leverages and tax parameters in the two markets. Furthermore, Lally (1998a) shows that the relevant market leverage for the foreign market is the average over the beta estimation period, along with the current value for New Zealand. The New Zealand equivalent to the foreign asset beta is then as follows

$$\beta_a = \beta_{aF} \frac{\left[1 + \frac{L_F}{(1-L_F)}(1-T_c)\right]}{\left[1 + \frac{L}{(1-L)}\right]} \tag{12}$$

where β_{aF} is the foreign beta estimate, L_F is the foreign market leverage averaged over the beta estimation period, T_c is the foreign company tax rate and L is current New

[45] The estimates are in fact taken from Value Line, and involve standard OLS regressions involving the previous five years of weekly data (with no adjustments). The market index is the NYSE composite.

Zealand market leverage. The absence of a company tax term for New Zealand is a reflection of the operation of dividend imputation here. 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 US company tax rate is 0.34. Following equation (12), the US asset betas of .35, .17 and .29 for electric utilities, gas distribution firms and the overall average are unchanged by this adjustment formula, i.e., the taxation and market leverage differences coincidentally net out.

Estimates of this type are subject to estimation error and vary with the length of the historical period. Consequently one should consider the results from a variety of periods. In respect of Damodaran, the fact that his current beta estimates are based on returns data over the last five years implies that 1998 estimates would be additional independent information. Damodaran (1998) presents industry average asset betas for that year, of 0.46 for both electric utilities (93 firms) and natural gas distribution firms (54 firms). However these averages involve degearing at the industry rather than the individual firm year, which is inappropriate. They are also clearly based on the Value Line "adjusted" betas rather than the raw regression betas, and this adjustment formula is of the Blume (1971, 1975) type. Lally (1998c) shows that this is biased upwards for low beta industries such as these. Thus, one needs to draw upon unadjusted betas for the individual firms. Unfortunately, this data is not displayed on Damodaran's website and attempts to obtain this 1998 data from both Damodaran and Value Line were unsuccessful. However, I am in possession of Damodaran's unadjusted individual company data for 2003. Conversion of the estimated equity betas to asset betas as before produces an average of .26 for the electric utilities and .17 for the gas distribution firms and an overall average of .23. By contrast, Damodaran's industry averages are .46 and .40. The discrepancy (of about .20) is primarily attributable to the use of the Blume betas[46]. Thus, Damodaran's 1998 industry average asset beta of .46 for both electric utilities and gas distribution would imply a value of about .26 if calculated in the way desired here, and this latter figure will be invoked. The adjustment in equation (12) requires the average US market leverage over the beta estimation period 1994-1998. Fama and French (1999, Figure

[46] Use of the individual company Blume betas to obtain asset betas, followed by averaging over the electric utilities, yields a figure of .44, which is very similar to Damodaran's industry average of .46.

1) give US market leverages for each the years 1994-1997, and the average is 0.27. Again, following equation (12), the adjustment for differences in market leverage and the taxation regime between the US and New Zealand has no net effect. So, the estimated asset beta for both US electric utilities and gas distribution firms remains 0.26.

A second source of estimates is Bloomberg, although only current estimates of the equity betas are available. The equity betas are estimated using the most recent two years of returns data, and are therefore more "recent" than the Damodaran estimates, although facing greater exposure to estimation error on account of the shorter period used[47]. Conversion of the equity to asset betas as above produces an average of .27 for the US electric utilities (68 companies), .20 for the gas distribution firms (25 companies) and an overall average of .25 (93 companies). Again, following equation (12), the adjustment for differences in market leverage and the taxation regime between the US and New Zealand has no net effect.

A third source of estimates is Alexander et al (1996, Appendix A2), using returns data from the period 1990-94. In this case, only asset betas are disclosed, with the de-gearing having been performed by the authors. The result is .30 for the electric utilities (9 companies), .20 for the gas distribution companies (12 companies) and .25 for firms with dual operations (14 companies). The overall average is .25. The adjustment in equation (12) requires the average US market leverage over the beta estimation period 1990-1994. Fama and French (1999, Figure 1) give US market leverages for each year in this period, and the average is 0.34. So, following equation (12), the resulting figures are .33 for the electric utilities, .22 for the gas distribution companies, .27 for dual-operation firms and .27 overall.

A fourth source of evidence is estimates provided by Ibbotson Associates (1998, 2004). Again, the equity beta estimates are based on the previous five years of returns data and are available for several earlier years. The most recent estimates (using 1999-2003 data) and those for 1998 (using 1993-1997 data) are used. Ibbotson reports only the industry median asset beta rather than the individual company figures,

[47] The data is provided courtesy of JBWere Goldman Sachs, with the authorisation of Bloomberg.

and the individual company estimates are based on the Vasicek (1973) adjustment process. Lally (1998c) identifies a number of difficulties in this process, although the effect on an industry median should be modest. For 2004, the figures given are .12 for electric utilities (41 firms) and .06 for gas distribution companies (9 firms), implying an overall average of .11. For 1998, the figures are .32 for electric utilities (66 firms) and .33 for gas distribution companies (42 firms), implying an overall average of .32. Again, following equation (12), the adjustment for differences in market leverage and the taxation regime between the US and New Zealand has no net effect.

A final source of estimates are those obtained from Standard and Poors. Their equity betas are estimated using five years of data, and estimates for 1989-1993, 1994-1998 and 1999-2003 were obtained. In respect of the electric utilities, conversion of the equity beta estimates to asset betas as before yields average asset beta estimates of .31 for 1989-1993 (36 firms), .19 for 1994-1998 (37 firms) and .18 for 1999-2003 (42 firms). For the gas distribution firms, the figures are .26 for 1989-1993 (29 firms), .32 for 1994-1998 (36 firms) and .19 for 1999-2003 (38 firms). Following equation (12), the adjusted results are .34, .19 and .18 for the electric utilities, whilst those for the gas distribution firms are .29, .32 and .19. The averages across the two sets of firms are .32 for 1989-1993, .26 for 1994-1998 and .19 for 1999-2003.

Table 3 below summarises these nine sets of results. The median for gas distribution firms (.22) is below that of electric utilities (.27). However, the overall discrepancy is less than one standard deviation of the estimate, and therefore is not statistically significant. In view of this, and the fact that my prior belief was for equal asset betas across the two industries, I propose to treat the data for the two industries as being drawn from the same underlying population. This leads to focusing upon the median of the overall results, which is .26. The outliers in the set of results are the most recent Ibbotson estimates. A possible explanation is offered by Annema and Goedhart (2003), who show that industry equity betas for the TMT sector (telecommunications, media and technology) were unusually high in the period 1998-2001, while those for other industries were unusually low. The reason here may be chance or a reflection of the (temporary) surge in the market weight of the TMT sector in the period 1998-2001[48]. If this is the explanation, then it has not affected the Standard and Poors results to this degree, and does not seem to have affected the Value Line results at all[49]. The outcome from simply ignoring all estimates that draw upon data from the period 1998-2001 inclusive is to raise the median of the overall results only slightly, from .26 to .30. Taking account of all this, I favour an estimate of .30 for the asset beta of US electric utilities and gas distribution firms.

Table 3: Asset Beta Estimates for US Firms

Source	Data Period	EUs	Gas	Overall
Value Line	1999-2003	.35	.17	.29
Value Line	1994-1998	.26	.26	.26
Bloomberg	2002-2003	.27	.20	.25
Alexander	1990-1994	.33	.22	.27
Ibbotson	1999-2003	.12	.06	.11
Ibbotson	1993-1997	.32	.33	.32
S & P	1999-2003	.18	.19	.19
S & P	1994-1998	.19	.32	.26
S & P	1989-1993	.34	.29	.32
Median		.27	.22	.26

The estimate just developed reflects rate of return regulation with annual resetting of prices, i.e., price-capping with annual resetting of prices so as to cover expected costs. By contrast, the New Zealand lines businesses face only price and quality thresholds

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

[49] Nevertheless the Value Line estimates did fall in the period 1998-2003. For example, Damodaran's industry average Blume betas for 2003, 2002 and 2001 are .46, .37 and .32 (each based on the preceding five years of data). Making the adjustment described earlier to remove the effect of using Blume betas (subtracting .20), this would yield estimates of .26, .17 and .12, which are more consistent with the Ibbotson results.

(set for up to five years[50]) with no direct linkage of the price threshold to costs. Consequently, their output prices could be expected to conform less closely to their costs than the US firms, and the effect of this would be to yield higher asset betas. Thus, the US estimate of .30 should be seen as a lower bound on that of the New Zealand lines businesses.

A second useful comparator is UK regulated firms in the gas and electricity industries. These firms were subject to price capping, with five yearly price resetting, in the period 1990-1994. Comparison of the asset betas of the US and UK firms in the period 1990-1994 will help to establish the effect of capping prices over a longer period than one year[51]. Alexander et al (1996) presents asset beta estimates for both these firms and their US counterparts, using data from the period 1990-1994. Only one UK gas firm is included, and therefore only the results for electric utilities are drawn upon. Alexander et. al. (ibid, Table 6.2) offers average asset betas of .30 for the US firms (9 companies) and .60 for the UK firms (17 companies)[52]. The difference is then .30, and this is in the direction suggested by theory. However this difference is contaminated by differences in market leverages. Lally (2004e) converts these figures into New Zealand equivalents of .36 and .56. Thus the effect of moving from US rate of return to UK price-cap regulation would seem to be to raise the asset beta of electric utilities by about .20.

The final step is to compare the regulatory environment for the New Zealand firms (price thresholds) with that of counterparts subject to five year price caps (as with the UK firms). The UK firms would be unable to raise their prices within the five year regulatory cycle in response to cost increases. By contrast, the New Zealand firms

[50] The term is five years for all firms except Transpower, for which a one year term applies (Commerce Commission, 2004c).

[51] These firms were privatised around 1990, and were subject to a five year price cap in the early 1990s. From the mid 1990s, the regulatory regime was altered essentially from price to revenue capping (Alexander et al, 1996). This removed exposure to volume shocks and this should have led to lower asset betas. Consequently, only their beta estimates for the early 1990s are useful for comparison with the US firms, to establish the effect arising from the length of the regulatory period. Similarly, regulated Australian electricity lines and gas pipeline businesses are not useful comparators because they are also revenue capped (ACCC, 1999).

[52] LECG (2001, p. 24) argue that the electricity generators should be excluded from the UK set referred to in Alexander. However the effect is merely to reduce the UK figure from .60 to .58. This is not only immaterial but would lead to a lower rather than a higher asset beta for airfields.

could raise prices, even over the price threshold (and they might not fear the resulting forward-looking investigation of excess profits if the price increase was merely in response to a cost increase). Accordingly, the price-capped firms would have higher asset betas than the New Zealand firms. In addition, the price-cap firms would also be subject to regulatory errors, some of which may increase their asset betas[53]. Finally, the price-cap firms may also have been less likely to have lowered their output prices within the regulatory cycle so as to conform more closely with costs (because their regulatory regime clearly encourages the earning of excess profits within the regulatory cycle, subject to the price cap); this is likely to have increased their asset betas relative to the New Zealand firms. Taking account of these factors, my judgement is that the New Zealand lines businesses would have lower asset betas than firms subject to a five-year price cap. Having already concluded that the New Zealand firms would have higher asset betas than the US firms, I consider that the asset beta for the New Zealand firms would lie about midway between that of the US rate of return regulated firms and that of the UK price-capped firms. This implies adding .10 to the asset beta of the US firms to reflect the effect of regulatory differences.

In summary, I use US electric utilities and gas distribution firms as a base, and estimate their asset beta (β_{Ea}) at .30. I then add a margin of .10 to reflect the difference in regulatory regimes between New Zealand and the US. This represents a margin (Δ) of .20 for five year price-cap regulation, subject to an adjustment factor (Q) of .50 to reflect the fact that the New Zealand lines businesses are more risky than the US firms but less risky than a five year price-cap situation. The result is a point estimate of .40, i.e.,[54]

[53] 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.

[54] An alternative approach would be to subtract the differential of .10 from the estimated asset beta for the UK firms rather than adding it to the estimate for the US firms. However the latter is preferred because more evidence is available concerning the US firms (see Table 3) and therefore they serve as a better base from which to make adjustments for regulatory differences in respect of the New Zealand firms.

$$\beta_a = \beta_{Ea} + Q\Delta = .30 + .50(.20) = .40$$

To formalise my uncertainty over these point estimates, I favour a standard deviation of .10 for the estimated asset beta of the US firms β_{Ea}, a standard deviation of .075 for the estimated price-cap margin Δ, and a standard deviation for Q of .33[55]. The standard deviation on Q reflects my uncertainty about where a typical electricity lines business would lie in the range between US rate of return and five-year price-cap regulation, and also an allowance for variation in the extent to which individual electricity lines businesses operate in a cost-plus fashion[56].

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 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 the New Zealand lines businesses, output prices are not explicitly controlled, but they may be granted a choice of HC or ODV asset value for purposes of assessing excess profits (Commerce Commission, 2004a). This choice of asset valuation methodology could be expected to accord with the basis on which the particular lines business sets its prices. If the chosen basis is HC, then it matches that for the US firms, and differs from the UK firms only in the depreciation path over time (which does not give rise to risk). If the chosen basis is ODV, this methodology is essentially optimised depreciated replacement cost. Only the act of optimising introduces risk, because changes in replacement cost are treated as income items and therefore only affect the depreciation path over time. Furthermore the act of optimisation would inject only industry specific risk at most, i.e., this would not be a market risk. Accordingly the

[55] For a normal distribution, a range of one standard deviation around the point estimate captures 68% of the probability distribution and two standard deviations captures 95% of the distribution, with the latter corresponding to virtual certainty. Thus, for example, I am virtually certain that the asset beta for the US firms is between .10 and .50.

[56] Lines businesses that operate in a more cost-plus fashion would have asset betas towards the lower end of the scale (.30), and those which are not embedded within private sector firms may be of this type. These include Transpower, community trusts, consumer trusts and councils. Quantifying variation across these entities does not seem to be feasible.

asset beta of the firm would be unaffected. So, in conclusion, differences in asset valuation methodologies would not appear to give rise to differences in asset betas.

Having suggested an estimate for the asset beta 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 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 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 electricity firms (subject to the points in the preceding paragraph). 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 but the median of .37 is close to the point estimate of 0.40 suggested here.

5.3 Contrary Views

A number of submissions by or on behalf of the lines businesses have argued for a higher value 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 (1996). Interestingly this is also the source for my upper bound of .50. The difference in outcomes is attributable to my undertaking 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. However, the Commission has decided to implement only price thresholds, and the argument offered is then irrelevant.

LECG (2003a) also favours a point estimate of .50. Starting with an estimate for US electric utilities of .35, based on Damodaran's estimate for 1998-2002 of .37, they add a margin of .20 to reflect the greater risk faced by the lines businesses, and then presumably round this to .50. In support of the margin of .20, they invoke my own margin of .20 for a five-year price cap and 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. However the lines businesses are only subject to price and quality thresholds. As discussed earlier this implies less risk than for firms subject to five year price caps. In respect of Damodaran's estimate of .37, this estimate is a Blume rather than a raw beta and is therefore inappropriate (as discussed in the previous section). Furthermore, consideration of a wider set of estimates in that section supports the estimate of .30 rather than .35.

In a subsequent submission, LECG (2003c) argue instead that the best estimate of Powerco's asset beta is obtained from Powerco's own returns data rather than from the data of "..some other more or less comparable firm" (ibid, p 8). However the use of returns data from only one firm exposes one to enormous estimation errors. These are illustrated in Table 2 in section 5.2, where the estimates for the three New Zealand firms are .48, -.10 and .19 for Powerco, United Networks and Horizon Energy respectively. Had LECG been representing United Networks in this matter, it seems unlikely that they would have placed any faith in the figure of -.10. Furthermore, the asset beta estimated from Powerco's own returns data could very well have been considerably larger than .48. In this case, LECG would then have argued for this much higher figure. The problem here is that beta estimates based upon the returns data of only one firm are statistically very unreliable. Because of this statistical problem, one is bound to draw upon returns data from other firms. In statistical terms, one is trading off bias against variance. Of course, there will be judgement questions in this area. LECG observes that there are particular difficulties in drawing upon beta estimates from foreign firms, and I concur (Lally, 2002c, 2004c). Nevertheless, if the foreign firms are ignored, then one is left with only three local firms. In my view this is too small a number to obtain a reliable estimate, and the median so obtained of .19 is hardly one that would appeal to Powerco.

LECG (2003c) also argue that the beta estimates obtained in the usual way are likely to be biased because they are estimated against a "market" portfolio that includes only equities rather than equities and risky debt. In particular, they argue that they will be biased down for reasons articulated in Ferguson and Shockley (2003). However this bias argument is incomplete. It is readily agreed that the market portfolio in the CAPM encompasses much more than equities. In fact it includes a great deal more than equities and risky debt. However the use of equities as a proxy for the market portfolio is driven by the lack of returns data on other assets. It is readily acknowledged that this gives rise to biases, but the biases are not limited to betas and extend to the estimation of the market risk premium (Lally, 1995, 2002d). In particular, if risky debt were included in the market portfolio proxy, then the effect would be to lower the estimate of the market risk premium. Thus, even if the effect of including risky debt in the market portfolio proxy were to raise the betas of the lines businesses, the downward effect upon the market risk premium may offset it.

PwC (2003a) also favours a point estimate of .50. In support of this they reiterate the arguments raised by Dunedin Electricity (2003) and LECG (2003a). 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. In this respect, the situation facing the two types of firms is similar. Thus the only specific example offered by PwC in support of their argument does *not* support a higher asset beta than .50. Furthermore, as argued earlier, a fuller consideration of the regulatory situation facing the two sets of firms points to a lower asset beta for the lines businesses.

NECG (2003b) also favours a point estimate of .50, and they offer two arguments. The first is that presented by LECG (2003a), and dealt with above. The second is that their point estimate is consistent with the estimate of PowerCo’s asset beta presented earlier in Table 2. However 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 upon. The results from one company, particularly when it appears to have been selected to support a conclusion, warrants even less attention.

On the other side of the industry, MEUG (2003a) argues for a point estimate of .35 rather than .40. This difference arises from an estimate of .20-.30 for US electric utilities rather than .30. However they offer no evidence in support of their band of .20-.30 for the US firms. In a subsequent submission MEUG (2003b) cite estimates of the asset beta for US electric utilities from Ibbotson Associates over the period 1996-2003, ranging from .32 to .05 (the most recent estimates being at the lower end of this range). They also note that estimates offered by Damodaran are considerably higher, and suggest that the discrepancy warrants investigation. As now discussed in the previous section, the Damodaran figures to which they refer are Blume betas (which are larger) and these are inappropriate. On the other hand, the low Ibbotson numbers are outliers.

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 are estimates drawn from large sets of foreign 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 a point estimate for the asset beta of the lines businesses diverging from .40.

6. Leverage

The WACC of a firm is affected by its leverage. In general, the possible measures of leverage include actual leverage, optimal leverage, and the firm’s target leverage. In the present context, in which an external party forms an assessment about excess profits, the choice must lie between the first two. 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 leverage of a firm cannot be directly determined, as it reflects a trade-off between competing considerations such as taxes, bankruptcy costs and the financial flexibility offered by debt. However, it could be inferred from examining the average level amongst relevant firms. Recent leverage values for firms within the industry are admissible, and the data shown in Table 2 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 next section).

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 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%[57]. Whether this is a sufficiently large figure to be troubled with is debatable. Furthermore, actual leverage cannot be determined for most of the lines businesses because it must be assessed in market value terms and this requires the firm to be listed. In view of all this, I recommend the use of optimal rather than actual leverage.

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 one of the lines businesses[58]. 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 (2003a) argue for an optimal leverage of zero, on the grounds that there is no tax benefit from debt. This claim is 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 levels suggests that the net effect is advantageous. Accordingly, I favour an optimal debt level based on observation of firms' leverages.

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

[58] This company is Horizon Energy whereas Emanuel is submitting in support of PowerCo. Even if PowerCo was still listed, his proposal for firm specific leverage levels could not be applied to all of the Lines Businesses.

7. 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[59], in recognition of leverage levels that were not especially high and operating risk that almost precluded bankruptcy[60]. 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.

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[61]. The best information in this area is recent market yields from traded bonds along with concurrent market value leverage. Amongst the lines businesses only PowerCo can offer both types of information, although the bond trades are infrequent. Trades for March 20, 2003 reveal a premium of about .012 along with market leverage of about .50[62]. Transpower also offers information on market yields but not market value leverage, and trades for March 20, 2003 reveal a premium of about .005. Vector also offers information on market yields but not market value leverage, and trades for March 20, 2003 reveal a premium of about .012. So, having recommended an optimal leverage figure of .40 for the lines businesses, 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.

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[59] The range spanning most companies is .01-.02 (JBWere Goldman Sachs, 2004).

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

[61] 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).

[62] 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.

If a higher leverage level were invoked, with an associated increase in the debt margin, the WACC would be increased, but not significantly. For example, suppose leverage was raised to 50%, and the debt margin raised from .012 to .014[63]. With the WACC governed by equations (1)….(5), WACC can be reduced to

$$WACC = k_u + p(1 - .33)L \tag{13}$$

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 .0032. With leverage at 50%, and the debt premium at .014, this term rises to .0047. The difference is only 0.15%.

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 20 March 2003 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 (2003a) 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. In a subsequent submission (LECG, 2003b), they appear to accept the appropriateness of a .012 margin. NECG (2003b) argue for a premium of .014 (on leverage of 50%), but they offer no data in support of this.

Finally, NECG (2003a, 2003b) and Bowman (2005) argue for adding an allowance for the costs of public debt issues, the above examples being of this type. In their first submission (NECG, 2003a) argue for .005. In support of this figure they invoke an issue cost of at least .025 (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

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

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 US 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) and discussion with New Zealand Investment Bankers indicates a similar figure here. Bowman (2005) argues for .018 to .024, on the grounds that the costs for New Zealand utilities would be more like those for US non-utilities, but he presents no evidence in support of this claim. So, the figure of .013 is used here.

Using a ten year bond term, the equivalent annual figure would be about .002. If a three year term was used, to match the assumed frequency of price resetting, then the equivalent annual figure would rise to .005. However, triennial refinancing is likely to be inferior to longer-term debt coupled with a swap contract to ensure exposure to triennial interest rate movements (with swap costs added to the issue costs). This suggests an allowance of about .003. Interestingly, NECG (2003b) suggests a similar figure of .002 in their subsequent cross submission. Invoking equation (13) above, the effect upon WACC of adding .003 to the debt premium would be less than .001. Furthermore, the inclusion of an allowance of this kind in WACC would require that all actual costs of this kind be removed from the firm's reported costs, and this may prove difficult. If it does not prove to be difficult, then the conceptual advantage lies in doing so and therefore raising the cost of debt by .003. If it does prove to be difficult, the effect of leaving these costs in the cash flows and not adjusting the cost of debt would appear to be slight[64].

In summary, a debt margin of .012 exclusive of issue costs is favoured. If debt issue costs can be easily identified in the firm's cash flows, they should be removed and a margin of .003 added to the cost of debt.

[64] In respect of the issue costs of equity, this is even less of an issue because most equity capital is drawn from retained earnings.

8. The 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[65]. 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.

[65] 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.

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). 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.

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 output prices whereas the shareholders of other lines businesses are concerned exclusively with dividends. This implies a lower WACC for consumer trusts than lines business with other ownership structures. However the extent to which consumer trusts have lowered output prices in substitution for dividends is simply indeterminable. So, one is bound to treat these entities in the normal fashion.

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

9. WACC

9.1 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 a standard deviation of .015 to formalise 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 excess profits assessment and used throughout the future review period. The three year rate is .063 (April 2005)[66]. The appropriate asset beta β_a for the lines businesses is assessed at .40, comprising two elements: firstly, an estimate for US electric utilities and gas distribution firms of β_{Ea} = .30 (standard deviation .10); secondly, a margin of .10 for differences in regulation between New Zealand electricity lines businesses and the US firms, comprising a margin of Δ = .20 for five year price-capping (standard deviation of .075) and an adjustment factor of Q = .50 to reflect lower risk on the New Zealand electricity lines businesses compared to five-year price-capped firms (standard deviation of .33). Finally, in respect of leverage L and the associated debt premium p, I recommend values of .40 and .012 respectively for all lines businesses, with an increment of .003 to the cost of debt for issue costs if they can be excluded from the cash flows. Excluding the debt issue costs, these parameter point estimates imply a cost of equity of .089 and a WACC of .073 as follows.

$$k_e = .063(1-.33) + .40\left[1+\frac{.40}{.60}\right].07 = .089$$

$$WACC = .60(.089) + .40(.063+.012)(1-.33) = .073$$

Addition of the debt issue costs to the cost of debt raises the WACC to .074. The point estimate on WACC reflects four parameters over which there is significant uncertainty, i.e., the market risk premium and the three components of the asset beta[67]. Such parameter uncertainty gives rise to uncertainty over WACC, and this can be formalised in a probability distribution for WACC[68]. The basis for this is the point

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[66] The five year rate reported by the Reserve Bank for April 2005 (being the average of the five year yields over that month) is .0609, which is then converted to a compounded annualised figure of .0618. Similarly, the two year rate is reported as .0627 and this implies a compounded annualised figure of .0637. The three year rate is then obtained by interpolation, yielding .0631.

[67] Uncertainty in respect of the remaining parameters (T_I and p) exerts only a trivial effect upon WACC uncertainty.

[68] This kind of analysis was suggested by NECG (2004).

estimates for the WACC parameters and the standard deviations of the four uncertain parameters. To translate the information about these four parameters into a probability distribution for WACC, an assumption is required about the relationship between these four parameters, and the assumption of independence seems appropriate, i.e., an under or over estimate in respect of one parameter has no implications for the direction of error in respect of any of the other three[69].

Invoking values for all parameters except the market risk premium and the asset beta, and excluding the debt issue costs, the WACC is as follows.

$$\begin{aligned} WACC &= [.063(1-.33) + \phi\beta_a(1.666)].60 + .075(1-.33).40 \\ &= \phi\beta_a + .045 \\ &= \phi\left[\beta_{Ea} + Q\Delta\right] + .045 \end{aligned}$$

Since the true but unknown values for these four parameters are independent, then the expectation of the WACC distribution matches the point estimate earlier of .073, i.e.,

$$E(WACC) = E(\phi)E(\beta_a) + .046 = .07[.30 + .50(.20)] + .045 = .073$$

Appendix 1 shows that the standard deviation of the estimated WACC is thus.

$$\sigma(WACC) = \sqrt{\sigma^2(\phi)\sigma^2(\beta_a) + E^2(\phi)\sigma^2(\beta_a) + E^2(\beta_a)\sigma^2(\phi)} \qquad (14)$$

In addition, the variance of the estimated asset beta is as follows.

$$\sigma^2(\beta_a) = \sigma^2(\beta_{Ea}) + \sigma^2(Q)\sigma^2(\Delta) + E^2(Q)\sigma^2(\Delta) + E^2(\Delta)\sigma^2(Q) \qquad (15)$$

[69] For example, consider the market risk premium and the asset beta. Suppose the market risk premium is estimated using historical averaging of the Ibbotson type and US data. It then draws upon US returns data over the last 70 years. In particular the level of returns matters. By contrast, the asset beta is largely estimated from US returns data over the last 15 years. In particular the sensitivity of electric utility returns to market returns matters (as opposed to the level of returns). These two sources of data would appear to be essentially independent. Furthermore, even if the beta and the market risk premium were estimated from the same data, multivariate normality in asset returns would imply the independence of these estimates (Fama and French, 1997).

Invoking the standard deviations and expectations for these parameters, it follows from the last two equations that $\sigma(\beta_a) = .13$ and $\sigma(WACC) = .011$. These results are summarised in Table 4 below.

Table 4: Means and Standard Deviations for Various Parameters

	β_{Ea}	Q	Δ	β_a	ϕ	$WACC$
Mean	.30	.50	.20	.50	.07	.073
σ	.10	.33	.075	.13	.015	.011

Assuming "normality" of the WACC distribution, the percentiles of the WACC distribution are then as shown in Table 5 below[70].

Table 5: Percentiles of the WACC Distribution

Percentile	50^{th}	60^{th}	70^{th}	80^{th}	90^{th}	95^{th}
WACC	.073	.076	.079	.082	.087	.091

Thus, if one wished to choose a WACC value for which there is only a 20% chance that the true value was less than this (80^{th} percentile), that WACC value would be 8.2%. If one seeks to reduce the probability of this error to 10% (90^{th} percentile), the WACC value rises to 8.7%.

Uncertainty over the true WACC value might lead to the use of a band of values from this distribution. Alternatively, one might choose a single value. In the latter case, it would be appropriate to choose a WACC value from above the 50^{th} percentile (this margin is denoted type 1), because the consequences of mistakenly concluding that excess profits exist are more severe than the contrary error (for at least some WACC values above the 50^{th} percentile). In particular, mistakenly concluding that excess

[70] If the distribution is not normal, then the percentiles in Table 5 change. Appendix 2 considers alternative distributions and shows that they generate approximately the same WACC values in the region from the 50^{th} to 95^{th} percentiles.

profits exist leads to unnecessarily incurring the costs of implementing and monitoring price control, damage to the Commission's credibility, and the *possibility* that price controls are set too low and therefore investment is deterred. The contrary (but less serious) risk is that control is not imposed when it should; consumers are then charged too great a price and businesses using electricity as an input face a cost burden that they may not be able to pass through. In respect of the point that the imposition of price control raises only the *possibility* of prices being set too low, this possibility may be quite low if a sufficiently large margin is added to the WACC estimate used in setting the output price under price control (type 2 WACC margin); this type 2 margin should protect against the possibility of the allowed output price being so low as to deter investment. Thus, prima facie, the risk of deterring investment may be a less significant concern in setting the type 1 WACC margin than in setting the type 2 margin. However the type 1 WACC margin should be at least as great as the type 2 margin, so as to avoid the possibility that control fails to "bite", i.e., prices at level X induce control but the resulting allowed output price is then set above X! Accordingly the type 1 WACC margin may implicitly incorporate a significant allowance for the risk of deterring investment.

Bowman (2005) argues that the WACC distribution should be generated from a Monte Carlo simulation because the distribution is skewed rightwards. LECG (2004) also favours a Monte Carlo analysis, presumably for the same reason. However, such a simulation would require knowledge of the shape of the probability distributions for each of the four underlying parameters for WACC, and these distributions are not known. An alternative approach is to examine some rightward skewed distributions for WACC, to determine whether there is much effect upon the WACC values in the relevant range (50^{th} to 95^{th} percentiles). This analysis is undertaken in Appendix 2, and reveals that the effect is trivial within this range.

LECG (2004) also contests the argument that the estimates for the four parameters underlying the WACC estimate are independent. However, they do not offer any grounds for contesting this.

9.2 Further Considerations

The results in the previous section reflect the WACC model that is used along with an allowance for possible errors in parameter estimates. However there are further potential concerns, including the possibility that the CAPM does not fully describe expected returns, that the version used is inappropriate, and the possibility of error arising from the fact that the "market" portfolio in the CAPM is proxied by listed equity. These concerns are raised by LECG (2003c). These issues give rise to further uncertainties concerning the WACC point estimate, and therefore suggest selecting a WACC value from an even higher level in the probability distribution. Although these additional uncertainties are in general impossible to quantify, one of them is amenable to quantification. This is the use of a domestic rather than an international version of the CAPM, and the effect is to raise the WACC by up to 1%. Such a bias may neutralise other possible errors (which effectively raise the standard deviation of the distribution) in the upper reaches of the WACC distribution[71]. Consequently, the argument for selecting a WACC value even further up the probability distribution presented above is countermanded.

Quantification of this potential bias from the use of a domestic version of the CAPM is now offered. Assessment of this effect involves choosing an international version of the CAPM, and the first such version is that of Solnik (1974). Inter alia, this version assumes that all sources of investment income are equally taxed at the personal level. Of course, this is inconsistent with equation (3), but the Solnik model implies that most investors in New Zealand assets would be foreigners, and tax differences across sources of income are likely to be less significant in this case[72]. So, one could assume that personal tax rates are equal in an international CAPM[73]. In this case, Solnik's model applies, and the cost of equity for a New Zealand company is

[71] For example, if the standard deviation of the WACC distribution is raised from .011 to .02 coupled with a reduction in the mean of the distribution from .073 to .065, the 80th percentile of the distribution remains at .082, i.e., a reduction in the mean WACC by .008 neutralises the effect of an increase in the standard deviation to .02, at the 80th percentile.

[72] One reason for this is that foreigners gain only slight benefits from dividend imputation credits, and therefore the tax rate on dividends is similar to that on interest. A second reason is that taxes of all kinds are more difficult to collect, and lower effective rates imply that any differences across types of income are less substantial in absolute terms.

[73] If taxes differences are retained in the model, as in Lally (1998d), then the reduction in WACC from the use of an international version of the CAPM is even greater.

$$k_e = R_f + MRP_w \beta_{ew} \tag{16}$$

where R_f is (as before) the New Zealand riskfree rate, MRP_w is the risk premium on the world market portfolio and β_{ew} is the beta of the company's equity against the world market portfolio[74]. The last two parameters must be estimated.

By contrast with equation (3), equation (16) assumes that world equity markets are integrated, i.e., investors will now be holding a world rather than a national portfolio of equities, and the latter portfolio will have a considerably lower variance due to the diversification effect. Since the market risk premium is a reward for bearing risk, then the world market risk premium under integration should be less than that for New Zealand under segmentation. This market risk premium cannot be estimated in the Ibbotson (2001) fashion, by averaging of the ex-post outcomes over a long period. This is because integration would reduce the market risk premium, and therefore the averaging process would have to be conducted over the period since integration (assuming it has been achieved). This would leave 25 years of data at most, and this is too short to be satisfactory. An alternative approach is suggested by Stulz (1995), who argues that, if the ratio of the market risk premium to variance (λ) is the same across countries under segmentation, the same ratio will hold at the world level under integration and this fact should be invoked in estimating the world market risk premium (the product of λ and the world market variance). As indicated in section 3.3, there is considerable controversy concerning the appropriate value for this ratio λ. Nevertheless, for the present purposes, the value chosen should generate results that are consistent with the estimate of the market risk premium for New Zealand under a domestic CAPM that was offered earlier. As discussed in section 3.3, this points to a value for λ of about 2[75]. Using this figure implies a market risk premium for the Solnik CAPM of

[74] In this model, the cost of equity for a New Zealand asset reflects the risk free rate for New Zealand coupled with a risk premium rather than a world average risk free rate coupled with a risk premium. The presence of the New Zealand risk free rate arises from an assumption in the model that every risky asset is identified with a particular market, and the asset's return in terms of that currency is independent of that currency's exchange rates against all other markets.

[75] So long as the estimate of the New Zealand market risk premium in a domestic CAPM is compatible with the chosen value for λ, the chosen value for the latter will not alter the conclusion that the world

$$MRP_w = 2\sigma_w^2 \quad (17)$$

Cavaglia et al (2000, Table 1) estimates the world market variance over the period 1985-2000 as $.135^2$, and the use of this period is consistent with that used in assessing the New Zealand market variance in section 3.3. Substitution of this estimated variance for the world market portfolio into equation (17) then implies an estimate for the world market risk premium of about .04.

Turning now to the question of betas, Bryant and Eleswarapu (1997, Table 5) estimate betas for various portfolios of New Zealand equities against the NZSE40 and the MSCI (world index), over the period 1973-1992. The average reduction in beta is 30%, implying an estimate of about 0.70. Using more recent data from 1980-2001, the resulting estimate is 0.77, and decomposing the latter period into the subperiods 1980-1990 and 1991-2001 yields estimates of 0.72 and 0.82. All of this points to an estimate of about .70, which is invoked[76].

I now estimate the cost of equity under equation (16). Using a risk free rate of .063, a market risk premium of .04 and an equity beta that is 30% less than that used in equation (3), the result is as follows.

$$k_e = .063 + .04[(.70)(.40)(1.67)] = .082$$

By contrast, the cost of equity arising under equation (3), and shown earlier, is .089. So, the use of a domestic rather than an international CAPM yields a cost of equity that is higher by about .007, due to both a larger market risk premium and equity beta. With leverage of 40%, this raises the WACC by about .40%. Inter alia, this result reflects an asset beta of .40. If the asset beta were raised to .50, which would be appropriate in a price control situation (see section 13), the choice of a domestic CAPM would then raise WACC by about 1%.

market risk premium under an international CAPM will be less than the New Zealand market risk premium under a domestic CAPM. Furthermore, higher values for λ will raise this differential in the market risk premiums.

[76] Ragunathan et al (2001) report even lower estimates for Australia.

NECG (2004a) disputes the contention that the use of a domestic CAPM would produce a higher cost of equity than use of an international CAPM. In particular, they cite Koedijk et al (2002), who present evidence that the costs of capital resulting from the domestic and international versions are very similar. Mishra and O'Brien (2001) present similar evidence. However both of these papers assume that the market risk premium in the domestic CAPM (MRP_d) is calculated in a fashion that is consistent with the international CAPM, i.e.,

$$MRP_d = MRP_w \beta_{dw} \tag{18}$$

where β_{dw} is the beta of the local market against the world market. This assumption is crucial to their conclusion. However, none of the estimation processes employed in this paper, or argued for by others such as NECG, match the process in (18). If equation (18) were employed, and using the estimates for the world market risk premium and the beta of the NZSE against the world portfolio presented above, the result would be as follows.

$$MRP_d = .04(.70) = .028$$

To this might be added a correction for the tax effect in equation (4), yielding a market risk premium for New Zealand of .048. Substitution of this into equation (3) would yield a cost of equity of .074. This is still less than the figure of .089 recommended in this paper, and this in turn is less than that suggested by NECG.

In summary, there is a choice. One option is to invoke equation (3) and to estimate the market risk premium in the way suggested in this paper. This yields a cost of equity under a domestic CAPM (.089) that is higher than that for the international CAPM calculated above (.082), implying upward bias from use of the former model. The second option is to estimate the market risk premium for equation (3) in the way suggested by Koedijk et al, and this leads to a cost of equity of .074 under the domestic CAPM (which differs from the result under the international CAPM due to taxes). In either case, the estimate for the cost of equity presented is this paper is likely to be too high.

In response to this argument, Bowman (2005, section 4.1) claims that his estimate of the New Zealand market risk premium is in fact consistent with Koedijk et al and Mishra and O'Brien, i.e., consistent with equation (18). Bowman (2005, section 3.7) considers a number of issues in estimating the market risk premium for New Zealand. His closest line of analysis to equation (18) is to estimate the market risk premium for New Zealand as the product of the US market risk premium and the beta of New Zealand against the US market, and this will coincide with equation (18) if he regards the US market as a good proxy for the world market. However, in his section 4.2, he quite explicitly distinguishes between the US and world market risk premiums. Thus, Bowman's estimate of the New Zealand market risk premium is not consistent with Koedijk et al and Mishra and O'Brien. Accordingly he cannot invoke their arguments in support of the proposition that the domestic CAPM approximates the international CAPM. Furthermore, Bowman's estimate for the beta of New Zealand against the US of 1.25-1.5 is pure speculation, and is inconsistent with the statistically derived estimate of .48 cited in NECG (2004b), i.e., inconsistent with Bowman's own statistically derived estimate.

Bowman (2005, section 4.2) also rejects the estimate of 0.70 for the beta of the New Zealand market against the world market, and appears to be suggesting that the figure should be greater than 1. However Bowman does not present any empirically derived estimate for New Zealand. He does nevertheless presents beta estimates for a number of other markets (from Harvey, 2000, Exhibit 1B), estimated over the period 1988-2000. If the New Zealand beta is estimated over that same period, the resulting estimate is 0.77, matching that for the longer period 1980-2001 reported above.

LECG (2004) argue that possible errors in estimating the cost of equity from using a domestic rather than an international version of the CAPM should give rise to a direct allowance for the error. However, the degree of error is not open to quantification, beyond observing that it will overestimate WACC by *up to* 1%, and this may compensate for other errors that effectively raise the standard deviation of WACC, at least in the upper reaches of the WACC distribution.

10. Comparison with Australian Regulatory Judgements

Having offered estimates of WACC for the lines businesses in New Zealand in the context of assessing excess profits, based on a particular model and parameter estimates, 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 rather than being tax free[77]. 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, 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 premium in the ACCC's model would translate into an estimate of about .066 for the CAPM model used in this paper (see section 3.3), and this can be compared with the estimate of .070 used here. 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 .066 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 .066 would have to be raised for proper comparison with the New Zealand figure of .070. All of this suggests that the figure of .060 used in the ACCC's model is consistent with the figure of .070 recommended here for the market risk premium in equation (4).

[77] 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.

In respect of the risk free rate, the ACCC's concern is with setting a price cap rather than assessing excess profits, and until recently it favoured a risk free rate equal to the length of the regulatory cycle (ACCC, 2001). This is to ensure that the present value of the firm's future cash flows match its initial investment (see Lally, 2002b, 2004a, for further detail). This is consistent with the view recommended in section 13 of this paper, in which price caps are examined. However, in response to the Australian Competition Tribunal's recent GasNet Decision, the ACCC has felt obliged to adopt the ten year risk free rate (ACCC, 2004, p 92)[78].

Regarding the asset beta, the Office of the Regulator General (2000, p 282) 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[79]. However these numbers are offered in the context of setting revenue caps for five years, and therefore are not directly comparable with the estimate of .40 offered in this paper for the purpose of assessing excess profits. Nor are the Australian numbers even directly comparable with betas for five year price caps, which are discussed in section 13 of this paper and for which an estimate of .50 is recommended. Revenue caps involve less risk to the firm than price caps, because exposure to volume shocks is removed. So, allowing for differences in the regulatory regimes, the Australian numbers appear to be consistent with the estimates suggested in this paper.

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

[78] This adoption appears to be without enthusiasm. In respect of a range of other issues examined by the ACCC, its decision is accompanied by a statement such as "..the Commission believes..". By contrast, in respect of using the ten year risk free rate, the Commission pointedly states that "As a result of the ACT's GasNet decision, the Commission will calculate a ten year risk free rate."

[79] 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).

differs from the .40 suggested in this paper. However, following the analysis in section 7, the effect of using the Australian leverage value would raise the WACC by only .16%.

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

11. Allowances for Other Issues

The analysis so far has yielded WACC estimates, based upon a methodology and parameter estimates. These WACC values provide rate of return compensation to investors for the time value of money and risk. Nevertheless, allowed rates of return sometimes incorporate (or could be argued to warrant) allowances for additional factors that are not inherently WACC issues, and these are considered here.

11.1 Asymmetric Risks

The first of these additional factors are called asymmetric risks, and they include 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, 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. The reasons for doing so include penalising over-investment (gold plating), technology improvements, and reductions in demand. Thus, demand shortfalls have both a stranding aspect (revenue shortfall) as well as possible consequences in the form of assets being optimised out.

In respect of these risks, and in the context of assessing excess profits, 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 option may be allowed by the Commission (Commerce Commission, 2004a).

In the event of assets being optimised out by the Commission, the resulting profit calculation would involve a smaller depreciation cost and a smaller base for determining its cost of capital. The excess profits assessed by the Commission will then rise, exposing the firm to the possibility of price control (to which the firm might feel bound to react by lowering its output price). In so far as the optimisation is induced by cost or demand changes as opposed to gold-plating (the former being beyond the control of the firm), some form of ex-ante protection would be warranted, and this could take the form of a “margin on WACC” or an ex-ante allowance in the cash flows. If the actual level of optimisations matches that reflected in the ex-ante protection, then the two effects offset. This paper does not attempt to assess the size of this compensatory margin and there are significant difficulties in doing so. 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 in response to such a cost shock, neither event will be reflected in the Commission’s forecasts of excess profits and the net effect of these omissions is zero. Thus, no action is required by the Commission. By contrast, if the business raised its prices ex-ante, and the Commission’s cost forecasts do not impound the expected incidence of such events (possibly because the costs forecasts are based on observed costs during a period in which no such events occurred), then forecast profits will appear to be excessive. In the same way, if an insurance company did not experience any large claims during a historical period, and used that experience to forecast the level of claims, it would appear to be charging excessive premiums. A possible response to this problem is to forecast costs using actual costs over a sufficiently long period that extreme events are represented to an extent that reflects their expected incidence. However, by virtue of these events being extreme, this outcome will always be difficult to attain. Thus, if excess profits are forecast, and the firm deals with these phenomena through ex-ante price adjustments, the Commission would have to form a judgement as to whether the forecast excess profits could be explained by extreme events that are not fully reflected in the cost forecasts. This requires some judgement about an appropriate ex-ante revenue increment to accommodate these costs (through a margin on WACC or a cash flow allowance), along with identification and removal of any costs of this type that are already impounded in the cost forecast. This paper does not attempt any assessment in this area. As noted earlier, there are significant difficulties in assessing appropriate ex-ante allowances.

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[80]. This gives rise to the "insurance problem" discussed in the previous paragraph. However the issue may not 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) and the lines businesses may have entered into bilateral contracts to manage such risks. Nevertheless, LECG (2003b) provides some examples from Orion's activities for which stranding risk could not be avoided.

Some of the issues analysed here involve an ex-ante allowance, through a WACC margin or directly in the cash flows, and this gives rise to the question of which approach is better. By their very nature these asymmetric risks are cash flow issues rather than discount rate issues, i.e., they are compensation for expected losses rather than investor aversion towards dispersion of actual outcomes around the expectation. Thus, a cash flow adjustment is the natural mechanism to use. Of course, there is always some discount rate adjustment that is equivalent to the cash flow adjustment, but it can *never* be determined until the cash flow adjustment is first articulated. Consequently, discount rate adjustments involve superfluous detail at best. At worst,

[80] If they were able to raise them ex-post then this would not constitute a stranding situation.

they are undertaken without first establishing the appropriate cash flow adjustment, and therefore simply disguise the failure to ever articulate the appropriate cash flow adjustment. For these reasons, I strongly favour cash flow over discount rate adjustments for these issues; this is generally described as an “implied insurance premium”. The ACCC (1999, 2001) also favours cash flow rather than discount rate adjustments.

Some of the issues examined here involve either ex-ante or ex-post actions by firms, and therefore requires a judgement by the Commission as to which approach is being employed by the firm. The Commission might put this question to the firm. If its response is to claim that these matters are addressed ex-post, the Commission might simply accept that on the grounds that the business has no incentive to falsely claim this. By contrast, if the business claims to engage in ex-ante adjustment, some evidence of that would be required. One possibility is evidence that it has not recently engaged in ex-post allowance, i.e., it did not raise prices in response to recent adverse events of the type in question.

11.2 Market Frictions: Costs of Financial Distress

LECG (2003b) argues that project volatility of the unsystematic type is costly, because losses on a project can make it costly or even impossible to raise further funds from capital markets. Without such funds, the firm may have to forego future valuable projects or shut down existing ones. This potential loss of value on other investments represents an additional cost to the firm’s providers of capital for which they require compensation, and they suggest an increment to WACC of 3%.

This issue involves shareholder exposure to a class of low probability adverse events arising from the failure of some or all of its projects, and high levels of unsystematic risk present the greatest concern here. The risk in question here is asymmetric, and is therefore akin to the discussion of miscellaneous adverse events in the previous section. The same approach by the Commission would then be warranted. In particular, the Commission should first ask whether the firm addresses the issue through ex-post adjustment of prices. If it does so, then no further action by the Commission is warranted. LECG offer no information on this question. By contrast, if the firm addresses the issue through an ex-ante adjustment of its prices, then the

Commission may have to form a view about the appropriate ex-ante allowance, and deduct this from the firm's revenues or equivalently add a margin to WACC. In addition, the firm's costs would have to be reduced by the level of any costs of this type that were already impounded into the cost forecast.

Assuming that the lines businesses engage in ex-ante adjustment of their prices, I now consider the appropriate level of the ex-ante allowance. Since the businesses are likely to possess the best information on this matter, and have clear incentives to overstate the extent of the problem, then it seems to me that a burden of proof lies with them. LECG do not offer any evidence about the behaviour of the lines businesses. Instead they offer evidence that firms in general use discount rates in excess of WACC estimates, and cite Poterba and Summers (1995) in support of this. However, this survey relates primarily to US firms, and therefore extrapolation to New Zealand firms warrants some caution[81]. More significantly, the observation is open to a number of possible interpretations, including allowance for project-specific risks, timing flexibility, and the use of high hurdle rates as an internal control device for countering overly optimistic cash flow forecasts.

Presumably mindful that various possible explanations exist, LECG offer evidence that project-specific risks are a significant element, in the form of papers by Mukherjee and Hingorani (1999), Keck et al (1998) and Graham and Harvey (2001). However there are a number of difficulties with these papers. First, most of the non-market risks referred to in the last two papers are macro-economic rather than project-specific, and therefore do not necessarily support the point under discussion[82]. Secondly, even in respect of Mukherjee and Hingorani in which project-specific risks are apparent, the quantitative effect upon hurdle rates is not indicated. Thirdly, reference to the actual behaviour of firms presumes that firms are acting appropriately, and yet both Keck et al and Graham and Harvey identify a number of ways in which the firms appear to be acting in error. If the firms are in error on some

[81] In fact, Poterba and Summers note that the margins applying in Japanese firms are considerably lower than for US firms.

[82] Consideration of the exposure to macro-economic shocks such as inflation in the course of setting a discount rate is consistent with the use of a multi-factor model like Arbitrage Pricing Theory (Ross, 1976), and this does not involve any recognition of market frictions.

points, they might also be unwittingly overstating the WACC margin to address project-specific risks.

In a subsequent submission, LECG (2003c) attempt to model the effect of market frictions, and invoke the work of Kerins et al (2003). However this paper is concerned with the increment to WACC that is required when investors in a firm are highly undiversified, most particularly in the case of venture capital operations. This is a quite different form of market friction to that discussed in LECG (2003b). Furthermore, it is a type of market friction that appears to have little relevance to the lines businesses. LECG (2003c, p 13) appear to recognise this point and argue that it merely illustrates the potential effect of market frictions. My view is that a significant burden of proof lies with the industry, and this kind of illustration does not discharge it.

LECG (2003c) also observe that hedging of risks is widespread, and argue that its prevalence is attributable to the importance of financial distress costs, i.e., hedging is undertaken to protect the firm against cash flow shocks that make it costly or impossible to raise external finance. From this it follows that the unsystematic risks that cannot be hedged by the lines businesses require a margin on WACC in compensation. In support of this argument, Froot et al (1993) is cited. However, as noted in the latter paper, there are a host of complementary explanations for the prevalence of hedging, including tax-based explanations and the risk aversion of corporate managers. Furthermore, this kind of evidence gives no insight into the size of the WACC margin even for firms in general.

LECG (2003c) also refer to the market for catastrophe insurance, and argue both that discount rates well in excess of those indicated by the CAPM appear to prevail and that this can be attributed to financial distress costs. In support of this, Froot (2001) is cited. Leaving aside the difficulties of estimating the expected return in such an industry, Froot's conclusion appears to be more guarded than suggested by LECG, in that he admits barriers to entry as a possible explanation for the apparently super-normal discount rates in the industry (ibid, p 569). Furthermore, this kind of evidence gives little guidance as to the appropriate WACC margin for the lines businesses.

In response to the suggestion that a burden of proof lies with the businesses, LECG (2004) argues that the burden lies with the Commission. By analogy, one could say that, in criminal law, the onus of proof lies with the prosecution rather than the defence. Nevertheless, if the defendant has access to a type of information that could point to their innocence (such as the provision of an alibi) and declines to supply such evidence, the jury could reasonably conclude that the information is unhelpful to the defence.

In summary, LECG have identified a potential basis for adding a margin to WACC, in the form of the costs of financial distress borne by shareholders. They present a wide range of evidence on the question, and conclude by arguing for an increment to WACC of 3%. However, a necessary condition for adding a margin to WACC is that the lines businesses deal with this issue through ex-ante rather than ex-post adjustment of their prices, and LECG offers no evidence on this question. Furthermore, even if the businesses engage in ex-ante adjustment of prices, any increment to WACC requires the netting out of any such costs that are already impounded into the cost forecasts. Finally, in respect of the appropriate ex-ante increment to WACC, I consider that a significant burden of proof lies with the industry. LECG offer no evidence directly relating to lines businesses, some of the evidence presented may be peculiar to the industries examined, explanations other than financial distress costs may be applicable in some cases, and the evidence concerning firms *in general* does not support either a particular choice of number or even the proposition that the size of the WACC margin is substantial. In light of all this, I do not recommend any adjustment to WACC for the costs of financial distress borne by shareholders. In so far as this is disadvantageous to the firms, this is part of a broader collection of judgements, and some of them are advantageous to the firms. In particular, the use of a domestic rather than an international version of the CAPM is likely to be advantageous to firms, as discussed in section 9.2.

11.3 Timing Flexibility

LECG (2003c) also argue that timing flexibility leads firms to delay investment past the point at which the present value first exceeds the project cost, and that this can be expressed as requiring a margin over WACC. They also suggest a margin of 6.6% for PowerCo. The general principle here that timing options exist, and that the firm’s optimal response is to delay until the expected rate of return exceeds the traditionally defined WACC by some margin, is not controversial (Dixit and Pindyck, 1994). However the significant issue is whether this margin *should be applied by the Commission in assessing excess profits*; LECG do not discuss this but they must be implying it.

To facilitate discussion, consider the following example. Suppose a proposed new project costs \$10m in plant, equipment, etc, its WACC is estimated (in the traditional way) to be 10% per year, and the future cash flows are currently expected to be \$1m per year indefinitely. The firm has flexibility in deciding the date on which to begin this project. If the firm invests now, the present value of the future cash flows is \$10m, and therefore the NPV is zero. However, delay may be optimal. In particular, suppose that it is not optimal to invest until the expected future cash flow equals \$1.7m per year. This is equivalent to saying that the firm should not invest until the expected rate of return on the \$10m investment is 17% rather than 10%. If the firm invests at this point, there is a "surplus" of \$0.7m per year over traditionally defined costs. If the cost of capital is defined in the traditional way then this "surplus" will constitute excess profits. By contrast, LECG appears to imply that the Commission should apply an allowed rate of return of 17% rather than 10%, for the purpose of assessing excess profits. If this were done, then no excess profits would be identified.

The fundamental issue here is whether this "surplus" of \$0.7m per year is an excess profit. If the timing option, and therefore the surplus, is a manifestation of market power then the surplus must be identified as an excess profit, and therefore defining WACC in the traditional way would be appropriate. Professor Boyle appears to concur with this (Gas Conference transcript, July 22, 2004, p 138). However he argues that this timing option might arise even in a competitive market, i.e., it may not be a manifestation of market power. In this case, it might be argued that the Commission should not identify the surplus as an excess profit, and therefore the traditionally defined WACC should be augmented by the 7% margin.

There are a number of difficulties with this argument. The first is as follows. LECG (2003c) tentatively suggests a margin of 6.6% for PowerCo, on a basis of a standard formula for which the crucial input is the volatility in PowerCo's return (.256).

However the use of this standard formula presumes that PowerCo *will* benefit from the timing option, and no evidence is offered on that question. PowerCo may never benefit from a timing option, but it may be exercising market power. Nevertheless, the application of the formula cited by LECG would still yield a margin of 6.6%, and addition of this to the traditionally defined WACC would merely serve to disguise the market power that was being exercised by them.

The second difficulty is that PowerCo may benefit from a timing option in respect of some but not all of its assets. However LECG's proposal would simply add 6.6% to the traditionally defined WACC of the company, for application to *all* of its assets. Under the assumed situation, this would be excessive.

The third difficulty is that PowerCo may benefit from a timing option, with the benefit *partly* but not entirely reflected in the exercise of market power. However the standard formula invoked by LECG cannot differentiate between these causes. Use of the formula to determine the WACC margin would then overstate the margin, and accordingly disguise the exercise of market power.

Further complications arise in considering other types of options. In particular, if the exercise of timing options warrants an increment to the WACC used for assessing excess profits, then the acquisition of "growth" options might warrant a reduction in the WACC used for this purpose[83]. It could be argued that there are no significant "growth" options in the electricity lines industry. However one might have said this about the telecommunications industry before the arrival of the internet.

The present situation resembles that in respect of the costs of financial distress, in the sense that the lines businesses are likely to possess the best information on this matter, and have clear incentives to overstate the extent of the issue. Consequently a significant burden of proof lies with them. However, the evidence offered by them is unpersuasive, on account of failing to demonstrate that any timing option was ever exercised, that it was exercised in respect of all of their assets, that it was unrelated to

[83] In this context, "growth" options represent opportunities to invest in NPV positive projects (in areas related to the core activity) that spring from the earlier investment in electricity lines.

the exercise of market power, and that it was not offset by other options. In view of this, I do not favour any provision of a margin to reflect the existence of these options.

Having said all this, it should be pointed out that there is a socially optimal point at which to invest, and regulators should be concerned whether firms do so and whether their regulatory processes obstruct that. However the regulatory exercise considered here is not one of price setting but of assessing excess profits. Furthermore, even if the regulatory process involved the setting of a price, there is no margin that can be added to WACC that would ensure that firms invest at the socially optimal time (or even at the point that they would in the absence of regulation). In fact, since a firm would receive the same margin regardless of when it invested, firms would be encouraged to invest at the earliest possible time so as to maximise the period for which the margin was earned. The fact that a WACC margin could be effective in optimising timing in an unregulated situation, but not a situation of price regulation, is due to the fact that the situations are quite different – revenues are largely exogenous in the first case and endogenous in the second.

11.4 Firm Resource Constraints

LECG (2003c) also argue that some firms are unable to undertake all desirable projects because of certain resource limitations such as managerial talent. So, undertaking any one project entails the sacrifice of other good projects, and this "..foregone opportunity is an additional capital cost of the current project" (ibid, p 11). Accordingly, a margin should be added to WACC in compensation. LECG do not seek to quantify this margin.

The argument here is similar in spirit to that of timing options in the previous section. In particular, the fact that a margin on WACC is appropriate for the purpose of assessing new investment does not imply that it will also be appropriate for the purpose of assessing excess profits. In fact, the existence of this opportunity cost *may* simply reflect the existence of excess profits on the adopted project, and adding a margin to WACC would simply undercut the whole process of seeking to identify those excess profits.

To illustrate the point, suppose that a firm has just been established and is confronted by two desirable projects. Both cost $10m to undertake, both have a WACC of 10%, and both are expected to generate net cash flows of $1.7m per year indefinitely. The net present value of each project is $7m. Suppose the firm can only undertake one of them, for the reasons noted by LECG, and does so. In doing so, there is a foregone opportunity worth $7m, which is equivalent to a WACC increment of 7%. If the $7m were a manifestation of the firm's market power, then it would be inappropriate for the Commission to add 7% to WACC and doing so would simply disguise the excess profits that are present.

As with the timing options, a significant burden of proof lies with the businesses, and their failure to even quantify the WACC margin reveals that this burden has not been discharged. Accordingly, I do not favour any WACC margin for firm resource constraints.

11.5 Information Asymmetries

LECG (2003b) argues that information asymmetries between existing and new shareholders increase the cost of capital. In particular, potential new shareholders know that existing shareholders have an incentive to issue shares to finance new projects when the latter know the company to be currently overvalued. Consequently the act of issuing new shares lowers the share price, and this is an additional cost that new projects face. This is equivalent to a margin on WACC in compensation. This argument concerning the hurdle rate on new investment is unobjectionable. However, the fact that a firm might be discouraged from undertaking *new* projects for fear that doing so would reveal the *true* situation within it (and it therefore raises the hurdle rate on new investment) does not have any bearing on the question of whether it is earning excess profits on its *existing* projects. Accordingly, it would be inappropriate for the Commission to add a margin to WACC, for the purpose of assessing excess profits. Furthermore, even in respect of new projects that are undertaken in these circumstances, it would be inappropriate for the Commission to add a margin to WACC, as this would constitute justifying higher prices to customers merely because existing shareholders in the firm have failed to convey information to new shareholders prior to the share issue. The appropriate solution to this informational problem is improved dissemination of information.

To examine this argument, consider the following example. A firm has just been established for an investment of $100m, a WACC of 10%, and is expected to generate cash flows of $30m per year indefinitely. The firm is therefore valued at $300m, with $200m of this being the present value of excess profits. Suppose new information now becomes available to controlling shareholders in the company suggesting that the expected cash flows are only $25m per year, i.e., the firm is overvalued by $50m. As a result they decline to adopt certain otherwise desirable projects because the act of issuing the shares might signal the overvaluation of $50m. Suppose this additional cost of undertaking the new projects is equivalent to a WACC margin of 15%. The situation here is one in which excess profits exist, and this remains true regardless of the firm's reluctance to adopt apparently desirable projects. However, if the WACC used by the Commission were raised by 15%, it would undercut the whole process of identifying the excess profits that are present.

This discussion assumes that the firm is overvalued. Suppose instead that the firm is correctly valued. Nevertheless, potential new shareholders might interpret an equity issue as a signal of overvaluation, and therefore the act of issuing the shares might lower the share price. In this event, the firm would appear to face a cost, at least in respect of new projects. However even this argument is unsupportable. If the share price falls due to a mistaken belief by new shareholders that the firm is overvalued, then new shareholders gain at the expense of existing shareholders. Shareholders in aggregate are unaffected. Accordingly, it would be inappropriate for the Commission to add a margin to WACC for the purposes of assessing excess profits.

12. Employing the WACC to Assess Excess Profits

12.1 Assessing Excess Profits in Dollar Terms

This section examines how a WACC estimate is used in the context of a forward-looking assessment 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, in general, the Commission's assessment of excess profits will be limited to some future period much less than the life of the firm. Thus we require a measure of excess profits that can be applied to any future review period, and which is equivalent to the NPV over the life of the business' existing projects.

One measure consistent with NPV is that of the "Present Value of Excess Earnings". For year t within the review period, "Expected Excess Earnings" is

$$E(Excess\ \ Earnings_t) = CF_t + REV_t - DEP_t - kB_{t-1} \tag{19}$$

where CF is the expected 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 Expected Excess Earnings for each year within the review period are discounted back to the beginning of the review period using the WACC, and summed. When this sum is determined for a review period equal to the life of the business, it is equal to the NPV. The proof of this is in Appendix 3. However, unlike the NPV, the "Present Value of Excess Earnings" can be calculated for any future review period. In addition, the Present Value of Excess Earnings can be converted to an equivalent annual figure.

An example is as follows. For a business with a life of three years, expected 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	Year 3
CF	\$10m	\$12m	\$9m
DEP	\$6m	\$7m	\$4m
CAP	\$3m	\$1m	0
k	.10	.10	.10

In addition, the initial book value of the assets is B_0 = \$11m. In conjunction with the DEP and CAP data above, this implies book values for the assets in one and two years of B_1 = \$8m, B_2 = \$4m and B_3 = 0. In this example, asset revaluations are ignored so as to simplify the example[84]. In addition, capital expenditures are assumed to occur at the end of a year, for the same reason[85]. The NPV is then

$$NPV = \frac{\$10m - \$3m}{1.10} + \frac{\$12m - \$1m}{(1.10)^2} + \frac{\$9m}{(1.10)^3} - \$11m = \$11.2m$$

Since this is positive then it is evidence of excess profits. Following equation (18), the "Expected Excess Earnings" for each of the three years are then as follows.

$$E(Excess\ Earnings_1) = \$10m - \$6m - (.10)\$11m = \$2.9m$$

$$E(Excess\ Earnings_2) = \$12m - \$5m - (.10)\$8m = \$6.2m$$

$$E(Excess\ Earnings_3) = \$9m - \$4m - (.10)\$4m = \$4.6m$$

The Present Value of these Excess Earnings is then

$$PV\ Excess\ Earnings = \frac{\$2.9m}{1.10} + \frac{\$6.2m}{(1.10)^2} + \frac{\$4.6m}{(1.10)^3} = \$11.2m$$

and this matches the NPV. However the "Present Value of Excess Earnings" can be calculated for any future period, and is therefore suitable as a test for excess profits over that period. For example, for the first two years:

$$PV\ Excess\ Earnings = \frac{\$2.9m}{1.10} + \frac{\$6.2m}{(1.10)^2} = \$7.76m$$

As noted earlier, this present value can be converted to an equivalent annual figure (X), which is the solution to the following equation.

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

[85] 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 4 discusses this issue in detail.

$$\frac{X}{1.10}+\frac{X}{(1.10)^2}=\$7.76m$$

The implied value for X is \$4.47m. Thus, the Expected Excess Earnings in the first two years are equivalent in present value terms to \$4.47m per year.

12.2 Assessing Excess Profits in Rate of Return Terms

An alternative approach to the assessment 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 forecast 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.

An alternative approach, generally referred to as the Internal Rate of Return (IRR), is as follows. Rather than determine the NPV, one could find the discount rate that present values the business's operating cash flows (net of capital expenditures) back to the initial investment; this discount rate is equal to the cost of capital plus a premium p. The NPV and the premium p have the same sign (both positive or both negative) and therefore convey equivalent information. For a business with a life of n years, and an initial investment of B_0, this premium p solves the following equation.

$$B_0=\frac{CF_1-CAP_1}{1+k+p}+\frac{CF_2-CAP_2}{(1+k+p)^2}+........+\frac{CF_n-CAP_n}{(1+k+p)^n}$$

Like the 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 expected book value of the assets at the end of the review period B_T as if it were a cash flow received at that time, and then calculates the premium with respect to the expected cash flows over the review period, the result is a rate of return counterpart to the "Present Value of Excess Earnings, i.e., for a review period of T years, the premium p solves the following equation.

$$B_0 = \frac{CF_1 - CAP_1}{1+k+p} + \frac{CF_2 - CAP_2}{(1+k+p)^2} + ... + \frac{CF_T - CAP_T + B_T}{(1+k+p)^T}$$

If the Present Value of Excess Earnings over the next *T* years is positive (negative), then the premium *p* will be positive (negative). The proof of this is in Appendix 5.

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

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

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 Expected Excess Earnings are then as follows.

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

$$E(Excess\ Earnings_2) = \$12m - \$3m - (.10)\$59m = \$3.1m$$

The Present Value of these Excess Earnings is

$$PV\ Excess\ Earnings = \frac{\$2m}{1.10} + \frac{\$3.1m}{(1.10)^2} = \$4.38m$$

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

$$\$60m = \frac{\$10m - \$1m}{1.10 + p} + \frac{\$12m - \$5m + \$61m}{(1.10 + p)^2}$$

The solution is p = .046. So, the forecast excess profits in dollar terms are \$4.38m and in rate of return terms are .046 per year.

In summary, excess profits over a future review period can be measured in dollar terms or in rate of return terms. The former measure is the Present Value of Excess Earnings, which can be annualised, and the latter is the rate of return premium. Both approaches are useful, and they are either both positive or both negative.

12.3 Revaluations of Land

Lally (2001c) also examines the issue of treating revaluations in the context of evaluating 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 evaluation of Excess Earnings, regardless of whether the businesses have taken them into account in setting their output prices. Failure to do so implies that excess 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. 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.,

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

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 evaluation 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 evaluation 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 evaluating Excess Earnings, the process would generate results that reveal the underlying economic situation of excess profits.

It might be thought that revaluations should be irrelevant to the setting of a business' output price, and therefore also in the evaluation 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

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

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)[86]. Suppose this sale occurs in 10 years, at an expected price of \$13.4m. Then the NPV of their investment will then be

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

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

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

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

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 evaluating Excess Earnings. For example, the expected result in the first year is as follows.

$$E(Excess\ Earnings_1) = \$1.04m(1-.33) + \$0.3m - .10(\$10m) = 0$$

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

12.4 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 evaluation 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 the evaluation of Excess Earnings over part of 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 evaluation of Excess Earnings should do likewise; if the business does not allow for them, neither should the evaluation 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 evaluation 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[87].

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

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

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

The present value of these Excess Earnings is zero, i.e., the same as when the revaluations are excluded. However, if Excess Earnings are evaluated for only the first year, the assessment 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* evaluating Excess Earnings using a different approach to that underlying the setting of prices[88]. This points to the evaluation 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[89]. In this event the evaluation 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.

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

[88] The same spurious conclusion would arise if the IRR approach were adopted, because the IRR and Present Value of Excess Earnings are equivalent (as shown in Appendix 5).

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

The *NPV* is then \$0.32m. So, revenues are excessive as a result of the business employing the pricing strategy described. If the evaluation 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, evaluating 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 only over 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 evaluation 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 over part of the asset's life[90]. However, if the business partially allows for revaluations in setting its output price, the evaluation of Excess Earnings should not adopt the 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

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

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 Earnings. 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 evaluating 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 evaluation 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 evaluation 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 evaluation 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 evaluating Excess Earnings.

In summary, with one exception, I do not consider that these arguments for omitting some revaluations from the evaluation 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.

12.5 Depreciation

Paralleling the situation for revaluations of depreciating assets, any evaluation 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 an evaluation is conducted over part of the asset's life. To illustrate this, the example at the beginning of section 12.4 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 evaluation 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.

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

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

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

12.6 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 (18) on page 75). 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[91].

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. 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

[91] The same point arises if the Commission removes stranded assets from the cost base used to evaluate Excess Earnings.

subject to assets being optimised out, the Expected Excess Earnings for the year, following equation (18), will be zero as follows:

$$E(Excess\ Earnings_1) = \$110m - \$100m - (.10)\$100m = 0$$

This is consistent with an NPV of zero. If, instead, the business is subject to the possibility of 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 expected Excess Earnings will be determined to be positive as follows.

$$E(Excess\ Earnings_1) = \$110m - \$95m - (.10)\$100m = \$5m$$

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

$$E(Excess\ Earnings_1) = \$110m - \$95m - \$100m(.15) = 0$$

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 expected Excess Earnings would then be -$5m as follows:

$$E(Excess\ Earnings_1) = \$110m - \$5m - \$95m - \$100m(.15) = -\$5m$$

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 evaluating Excess Earnings.

12.7 The Joint Cost Problem

The assessment 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.

12.8 Statistical Estimation Issues

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. This implies that observed Excess Earnings would have to be well in excess of zero before concluding that the underlying situation was characterised by excess profits. However, it is implicit in this thinking that the evaluation is conducted upon past rather than future Excess Earnings. Furthermore, the standard tests would require that the annual figures be independent. Neither assumption is valid. Furthermore the data suffer not just from the possibility of being unrepresentative of the underlying population but also from the possibility of 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. Since a classical statistical test cannot be applied, one must attach bounds to their point estimate and these bounds are a matter of judgement. Various submissions reiterate this point (for example, LECG, 2003a) but offer no methodology for determining how large Excess Earnings can be before concluding that the underlying situation is characterised by excess profits. Sections

9.1 and 9.2 attempt to address the issue of possible errors in estimating parameter values, but this is a distinct point.

12.9 Tax Issues

Section 12.1 defines Excess Earnings, which includes allowance for corporate taxes in operating cash flows (unlevered tax) and in WACC (through the tax deduction for interest payments). Determination of the appropriate corporate tax expense for the purpose of assessing Excess Earnings involves two particularly significant issues. The first involves the choice between "tax payable" and "tax expense", with the former arising from applying the statutory tax rate to taxable income and the latter arising from applying the statutory tax rate to accounting income net of permanent differences. The principal source of difference here is depreciation, with "tax payable" using the depreciation expense recognised by IRD and "tax expense" using regulatory depreciation. Lally (2002) shows that tax depreciation should be used in determining the tax figure within Excess Earnings, because it yields Excess Earnings whose present value over the life of a project matches the NPV of the project's cash flows. The same argument extends to other sources of difference between "tax payable" and "tax expense".

The second issue concerns the treatment of tax losses, and the recommendations are as follows. Firstly, if tax losses are present, and realisation of them (by offsetting them against future tax obligations) is deferred for only a short period, then the deferral could be undertaken or simply ignored; in the latter case the tax losses are treated as immediately giving rise to a tax rebate. By contrast, if deferral occurs for many years, then present value corrections should be undertaken to the tax saving, in recognition of the fact that deferral of these tax savings lowers their present value. If there is sufficient doubt as to the eventual realisation of these tax savings, then they should be present valued to zero. Secondly, if the lines business in question is part of a larger entity that is able to offset at least part of the tax losses for the lines business, then the tax savings arising from the portion of the tax losses that can be immediately offset requires no present value adjustment and the present value adjustments to the remainder will tend to be smaller and possibly unnecessary. Finally, if there are accumulated tax losses at the beginning of the review period, then realisation of any tax losses arising *during* the review period will be delayed even further than otherwise. Accordingly, the present value adjustments to the tax savings arising from tax losses will tend to be larger.

A further issue concerns the mechanics of any such adjustments for tax losses. If the interest tax deduction is incorporated within WACC, as shown in equation (1), then any attempt to adjust it to reflect the extent to which tax losses delay or eliminate the ability to use this tax deduction gives rise to considerable complications (as discussed in Lally, 2004f, 2004g). Considerable simplification arises from incorporating the interest tax deduction within the allowance for taxes in operating costs rather than in WACC, i.e., the WACC is stripped of the interest tax deduction (yielding a "vanilla" WACC) and the tax term appearing in the cash flows is levered tax rather than unlevered tax[92]. The effect of tax losses is then entirely captured in the cash flows. This practice could be adopted in all cases or only in those cases in which tax losses arose. However, the difficulty in doing either is that the use of a vanilla WACC would be inconsistent with the Commission's practice in other regulatory situations. An alternative would be to define the tax term in the cash flows as levered tax (term 1) plus the full interest tax shield (term 2), and allow the full tax deduction for interest in the WACC (term 3). The last two terms offset each other and the effect of tax losses is entirely captured in the first of these three terms. This achieves all of the computational simplifications of the vanilla WACC approach whilst invoking a definition of WACC that is consistent with the Commission's practice in other regulatory situations. However the tax term appearing in the cash flows is neither the levered tax nor the unlevered tax.

To illustrate these alternatives, suppose the interest tax shield in the current year is \$100, only half of this can ever be utilised due to tax losses, and the tax figure applicable to the unlevered entity is \$1000. If the adjustment is performed through the WACC, then the WACC tax deduction for interest must be halved and the tax figure in the cash flows is \$1000. Using the vanilla WACC approach, the WACC excludes any interest tax deduction and the tax figure employed in the cash flows is the levered tax of \$950. The last approach is to invoke a WACC inclusive of the full

[92] This practice is followed by the Australian regulators

deduction for interest along with a tax figure in the cash flows of \$950 + \$100 = \$1050. All three approaches will lead to the same regulatory revenues.

13. Estimating WACC in Setting a Price Cap

In the event of investigating a breach of the price or quality thresholds by a Lines Business, and concluding that excess profits are present, 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 investigation. Several points of difference arise, as follows.

First, the estimation of WACC in the earlier investigation 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 in section 5, 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 5.2 would be .50 (being .30 for one year price caps plus an increment of .20 for five year caps). Accordingly the point estimate for WACC inclusive of the tax deduction for interest then rises from .073 to .080 as follows.

$$k_e = .063(1-.33) + .50\left[1+\frac{.40}{.60}\right].07 = .101$$

$$WACC = .60(.101) + .40(.063+.012)(1-.33) = .080$$

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 price-capped electric utilities, whereas the prior situation is equated with circumstances between those of US and

UK firms. Following the analysis in section 9.1, the standard deviation on this figure rises slightly to .012.

Second, the estimation of WACC in the earlier investigation may employ 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. That number might be drawn from the upper or lower end of the distribution rather than the middle. I favour drawing it from the upper end, because the consequences of setting the WACC too low (in the form of deterring investment) are more severe than the consequences of setting it too high (in the form of imposing excessive prices upon consumers)[93].

Third, as demonstrated in Lally (2002b, 2004a), the term of the risk free rate used in price capping should accord with the term of the price cap. 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 excess profits have arisen (pre-control), because prices are not so clearly fixed for a defined period.

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)[94]. 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

[93] This issue is discussed more fully in section 12.1.

[94] 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.

investment is forthcoming, one must err on the generous side[95]. 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.

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.

[95] 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.

14. 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 assessing excess profits, the model recommended is that used in the Airfields Report. In addition the parameter values recommended are a market risk premium of 7% (compared to 8% in the Airfields Report), use of the three year risk free rate (set at the beginning of the review period and used throughout it), an asset beta for all of the lines businesses of .40, leverage of .40, and a debt premium of 1.2%. If debt issue costs can be readily identified in the firm's cash flows, they should be excluded and a margin of .3% added to the cost of debt. 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 this model, these parameter values, and the three year risk free rate of 6.3% (April 2005 average), the point estimate on WACC is 7.3% (adding debt issue costs to the cost of debt raises this figure to 7.4%). In recognition of possible estimation errors for some of these parameters, the standard deviation of the WACC estimate is estimated at 1.1%. Other types of possible errors are not open to quantification in this way.

This WACC estimate may be adjusted to take account of additional issues that are not inherently WACC issues. Asymmetric risks present certain difficulties. In so far as the possibility of asset stranding and miscellaneous adverse risks such as natural disasters are dealt with by firms raising their output prices ex-ante, this gives rise to the problem that forward-looking assessments of excess profits will be incorrect unless cost forecasts reflect the expected incidence of these events, possibly through a margin added to WACC along with removal of any such costs that are already impounded into the cost forecasts. In addition, 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 may be warranted. 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 may be warranted.

In respect of the costs of financial distress, the situation in principle is similar to that of asset stranding and natural disasters. However, even if firms raise their prices ex-ante in compensation for the possibility of financial distress, and a regulator was able to identify any costs of this type that were already impounded into the cost forecasts, no convincing evidence is available that the appropriate ex-ante adjustment to output prices is substantial. Accordingly, I favour no increment to WACC or otherwise to cash flows for the costs of financial distress borne by shareholders. In so far as this is disadvantageous to the firms, this is part of a broader collection of judgements, and some of them are advantageous to the firms. In particular, the use of a domestic rather than an international version of the CAPM is likely to be advantageous to firms.

Finally, in respect of timing options, firm resource constraints, and information asymmetries, I do not consider that any margin should be added to WACC for the purpose of assessing excess profits.

In respect of the process by which a WACC estimate is used to assess excess profits, two approaches are suggested. The first is to determine the Present Value of Excess Earnings over the future review period, and this present value could be converted into an annual equivalent. The second is a variant on the IRR methodology, involving calculation of the expected rate of return premium relative to the cost of capital. The Present Value of Excess Earnings has the advantage of expressing the outcome in dollar terms, and the contributions of individual years 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 depreciating assets, they should be included or excluded from the assessment 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, and is granted ex-ante compensation for this, 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 evaluating Excess Earnings, these events should *not* be included within "Revaluations" in the evaluation of Excess Earnings.

Having carried out this assessment of excess profits, a price cap may then be imposed upon a lines business. In doing so, the WACC estimate employed may differ from that used in evaluating excess profits, 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, any bands around WACC must now be replaced by a single figure, and a figure in excess of the point estimate is recommended. Third, the term of the risk free rate must accord with the term of the price cap. Finally, in respect of asymmetric risks, the Commission would have to decide whether to incorporate an ex-ante allowance for them into the output price, or offer ex-post compensation in the event of relevant events occurring.

APPENDIX 1

This appendix seeks to prove equations (14) and (15), involving the relationship between the variance of the WACC distribution and the properties of the five uncertain parameters that are embedded within it. It is assumed that these five parameters are independent of one another. Following section 9.1, the WACC is related to these parameters as follows.

$$WACC = \phi\beta_a + .045$$

where

$$\beta_a = \beta_{Ea} + Q\Delta$$

Invoking the independence assumption, the variance of the distribution for WACC is as follows.

$$\begin{aligned}
Var(WACC) &= Var(\phi\beta_a + .045) \\
&= Var(\phi\beta_a) \\
&= E\left[\phi\beta_a - E(\phi)E(\beta_a)\right]^2 \\
&= E(\phi^2)E(\beta_a^2) - E^2(\phi)E^2(\beta_a) \\
&= \left[Var(\phi) + E^2(\phi)\right]\left[Var(\beta_a) + E^2(\beta_a)\right] - E^2(\phi)E^2(\beta_a) \\
&= Var(\phi)Var(\beta_a) + E^2(\phi)Var(\beta_a) + E^2(\beta_a)Var(\phi)
\end{aligned}$$

This is equation (14). Invoking the independence assumption again, and using the result in the last equation for the variance of a product:

$$\begin{aligned}
Var(\beta_a) &= Var(\beta_{Ea} + Q\Delta) \\
&= Var(\beta_{Ea}) + Var(Q\Delta) \\
&= Var(\beta_{Ea}) + \left[Var(Q)Var(\Delta) + E^2(Q)Var(\Delta) + E^2(\Delta)Var(Q)\right]
\end{aligned}$$

This is equation (15).

APPENDIX 2

This appendix examines the implications of departures from normality in the WACC distribution. Since the WACC involves the product of the market risk premium and the asset beta, some rightward skewness in the WACC distribution is to be expected, and this is inconsistent with the use of a normal distribution. In addition, WACC should be at least zero and the density function should go to zero as WACC does. Two distributions that satisfy these properties are examined, being the lognormal and gamma distributions.

In respect of the lognormal distribution, this is as follows

$$Ln(WACC) = a + bZ$$

where a is the expectation of the lognormal distribution, b is the standard deviation and Z is the standard normal random variable. So

$$WACC = e^{a+bZ} \tag{20}$$

Consequently (see Mood et al, 1974, Chapter 3)

$$E(WACC) = e^{a+.5b^2}$$
$$Var(WACC) = E(WACC^2) - E^2(WACC)$$
$$= e^{2a+2b^2} - E^2(WACC)$$

The values for $E(WACC)$ and $Var(WACC)$ have already been determined as .073 and $.011^2$ respectively. So

$$.073 = e^{a+.5b^2}$$
$$.011^2 = e^{2a+2b^2} - .073^2$$

Simultaneous solution yields a = -2.6285 and b = .150. Substitution into equation (20) yields

$$WACC = e^{-2.6285+.150Z} \tag{21}$$

This lognormal distribution is now used to generate percentiles of the WACC distribution, and compare them with the earlier results from assuming that WACC is normal rather than lognormal. The results are shown in Table 6 below. For example, the 50^{th} percentile of the WACC distribution corresponds to $Z = 0$, and substitution of this into equation (21) yields WACC = .073. This is slightly less than for the normal distribution. However, as the percentile increases, the WACC value under the lognormal distribution increases more rapidly than for the normal distribution, and overtakes it at around the 90^{th} percentile. However, within the region from the 50^{th} to the 95^{th} percentiles, the results are virtually identical[96].

Table 6: Percentiles of the WACC Distribution

Percentile	50^{th}	60^{th}	70^{th}	80^{th}	90^{th}	95^{th}
WACC (Normal)	.073	.076	.079	.082	.087	.091
WACC (Lognormal)	.072	.075	.078	.082	.087	.092
WACC (Gamma)	.072	.075	.078	.082	.087	.092

The gamma distribution is now considered. This has two parameters, λ (scale) and r (location). The expectation and variance of the gamma distribution are as follows (Mood et al, 1973, Chapter 3)

$$E(WACC) = \frac{r}{\lambda}$$

$$Var(WACC) = \frac{r}{\lambda^2}$$

Matching this mean and variance to the previously determined values of .073 and $.011^2$ respectively yields $r = 44$ and $\lambda = 603$. With these parameter values, the

[96] By contrast, at the 99.75^{th} percentile ($Z = 3$), the WACC value under a normal distribution is .106 whilst that under a lognormal distribution is .113.

percentiles of the gamma distribution are then determined and reported in Table 6. To the third decimal point reported, they match the lognormal distribution.

In summary, for given mean and variance, WACC distributions that are skewed rightwards generate essentially the same WACC values as the normal distribution in the region of the 50^{th} to the 95^{th} percentiles.

APPENDIX 3

This appendix proves that the Present Value of Excess Earnings over the life of a project is equal to the NPV of the project. 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 expected operating cash flow for the year ending at time t, CAP_t be the expected capital expenditure for the year ending at time t, and k_t be the discount rate for year t. The NPV is then

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

The initial book value B_0 can be expressed as follows.

$$B_0 = \frac{B_0 + B_0 k}{1+k} = \frac{B_1 + DEP_1 - REV_1 - CAP_1 + B_0 k}{1+k}$$

Substitution of this into the preceding equation yields

$$NPV = \frac{CF_1 + REV_1 - DEP_1 - B_0 k}{1+k} + \frac{CF_2 - CAP_2}{(1+k)^2} - \frac{B_1}{1+k}$$

The time 1 book value B_1 can be expressed as follows.

$$B_1 = \frac{B_1 + B_1 k}{1+k} = \frac{DEP_2 - REV_2 - CAP_2 + B_1 k}{1+k}$$

Substitution of this into the preceding equation yields

$$NPV = \frac{CF_1 + REV_1 - DEP_1 - B_0 k}{1+k} + \frac{CF_2 + REV_2 - DEP_2 - B_1 k}{(1+k)^2}$$

$$= \frac{E(Excess\ Earnings_1)}{1+k} + \frac{E(Excess\ Earnings_2)}{(1+k)^2}$$

This completes the proof. The reasoning here parallels that in Ohlson (1995).

APPENDIX 4

This appendix examines the question of how the timing of capital expenditures, disposals and revaluations should be handled in the context of evaluating 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 evaluation of Excess Earnings. If the evaluation recognises the exact timing of the capital expenditures then the expected Excess Earnings are as follows.

$$E(Excess\ Earnings_1) = R_1 - DEP_1 - .10BV_0 = \$80m - \$70m - .10(\$100m) = 0$$

$$\begin{aligned} E(Excess\ Earnings_2) &= R_2 - DEP_2 - .10BV_1 - .0913(\$50m) \\ &= \$87.56m - \$80m - .10(\$30m) - .0913(\$50m) = 0 \end{aligned}$$

So the Expected 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 Expected Excess Earnings for year 2 would have been as follows.

$$E(Excess\ Earnings_2) = R_2 - DEP_2 - .10BV_1 = \$87.56m - \$80m - .10(\$30m) = \$4.56m$$

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 evaluating 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.

$$E(Excess\ Earnings_1) = R_1 - DEP_1 - .10(\$50m) - .0488(\$55m)$$
$$= \$112.68m - \$105m - .10(\$50m) - .0488(\$55m) = 0$$

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

In summary, in evaluating 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 evaluation 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 determination of expected Excess Earnings.

$$E(Excess\ Earnings_1) = R_1 - DEP_1 - .10BV_0 = \$60m - \$50m - .10(\$100m) = 0$$

$$E(Excess\ Earnings_2) = R_2 - DEP_2 - .10BV_1 = \$55m - \$50m - .10(\$50m) = 0$$

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

We now consider what happens if the asset is expected to be revalued at the end of the first year, by \$20m. The revenues would then be set 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 Expected Excess Earnings are as follows.

$$E(Excess\ Earnings_1) = R_1 - DEP_1 - .10BV_0 + REVAL_1$$
$$= \$50m - \$60m - .10(\$100m) + \$20m = 0 \quad (22)$$

$$E(Excess\ Earnings_2) = R_2 - DEP_2 - .10BV_1 = \$66m - \$60m - .10(\$60m) = 0$$

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 Expected Excess Earnings are still zero in each year.

We now suppose that the \$20m revaluation is expected to be 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 evaluation of Excess Earnings 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.

$$E(Excess\ Earnings_1) = R_1 - DEP_1 - .10BV_0 - .0488REVAL + REVAL(1.0488)$$

$$= \$50m - \$60m - .10(\$100m) - .0488(\$20m) + \$20m(1.0488)$$
$$= 0$$

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 (22) 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 evaluation 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 5

This appendix proves that the Present Value of Excess Earnings over a review period is 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

$$B_0 = \frac{CF_1 - CAP_1}{1+k+p} + \frac{CF_2 - CAP_2 + B_2}{(1+k+p)^2}$$

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

$$B_0 + \alpha = \frac{CF_1 - CAP_1}{1+k} + \frac{CF_2 - CAP_2 + B_2}{(1+k)^2}$$

where α is the dollar counterpart to the premium p, i.e., α is positive (negative) if the premium p is positive (negative). The initial book value of the assets can be expressed as

$$B_0 = \frac{B_0 + B_0 k}{1+k} = \frac{B_1 + DEP_1 - REV_1 - CAP_1 + B_0 k}{1+k}$$

Substituting this into the previous equation yields

$$\alpha + \frac{B_1}{1+k} = \frac{CF_1 + REV_1 - DEP_1 - B_0 k}{1+k} + \frac{CF_2 - CAP_2 + B_2}{(1+k)^2}$$

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

$$B_1 = \frac{B_1 + B_1 k}{1+k} = \frac{B_2 + DEP_2 - REV_2 - CAP_2 + B_1 k}{1+k}$$

Substituting this into the previous equation yields

$$\alpha = \frac{CF_1 + REV_1 - DEP_1 - B_0 k}{1+k} + \frac{CF_2 + REV_2 - DEP_2 - B_1 k}{(1+k)^2}$$

$$= \frac{E(Excess\ Earnings_1)}{1+k} + \frac{E(Excess\ Earnings_2)}{(1+k)^2}$$

The right hand side is the Present Value of Excess Earnings over the review period. So, the Present Value of Excess Earnings equals α, and the latter is equivalent to the premium p. So, the premium p is equivalent to the Present Value of Excess Earnings, i.e., if one is positive (negative), the other is positive (negative). This completes the proof.

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