THE WEIGHTED AVERAGE COST OF CAPITAL FOR GAS PIPELINE BUSINESSES

Martin Lally
Associate Professor
School of Economics and Finance
Victoria University of Wellington

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EXECUTIVE SUMMARY

The Commerce Commission has recently commenced an investigation into the question of whether gas pipeline businesses (transmission and distribution) should be subject to increased regulatory control. In particular, they will be assessing whether "control" should be declared. Inter alia, this may involve an assessment of excess earnings, i.e., earnings net of the cost of capital. This in turn requires estimation of the appropriate Weighted Average Cost of Capital (WACC) for these businesses. The purpose of this paper is to assess this WACC, and the primary conclusions are as follows.

The model for determining the WACC is the nominal model recommended in the Commission's inquiries into airfield operations and electricity lines businesses. In addition the parameter values recommended are a market risk premium of 7% along with bands of 6-8% (as with the Lines Businesses, and compared to 7-9% in the Airfields Report), use of the three year risk free rate, an asset beta for all of the gas pipeline businesses of .50 with bands of .40-.60, leverage of 40%, and a debt premium of 1.2%. The form of ownership of the gas pipeline businesses should not be a factor in estimating the WACC, except in so far as it affects the asset beta, and this appears impossible to quantify. Using these parameter values, and the current (July 2003 average) three year risk free rate of 5.0%, the lower limit on WACC, the point estimate, and the upper limit are 6.1%, 7.2% and 8.5% respectively. Given that there is some uncertainty as to the correct parameter estimates, and that the consequences of judging excess profits to exist when they do not are more severe than the contrary error, my view is that one should choose a WACC value from the higher end of the scale. The model used here for estimating the cost of equity capital is a domestic version of the CAPM, and this produces a cost of equity that is likely to be too high. This provides further protection against the possibility of using a WACC estimate that is too low. The WACC model used here is also nominal rather than real, and it is demonstrated that the former is superior in assessing excess earnings.

Asymmetric risks present particular difficulties. In so far as the possibility of asset stranding and miscellaneous adverse risks such as natural disasters is dealt with by firms raising their output prices ex-ante, this gives rise to the problem that excess profit assessments will be too high unless such events have occurred. Corrections for this present considerable informational difficulties to regulators. In addition, the process of regulators optimising assets out for any reason other than indisputable cases of gold-plating requires some form of ex-ante compensation, and failure to provide this implies that excess profits will be overestimated. Even if an appropriate allowance is provided, this still leaves the problem that excess profits will be over or under estimated if the actual level of optimisations is more or less than provided for in the allowance. The last of these issues involves positive and negative errors, and could simply be ignored if the errors were thought to be slight. The remaining issues will generally give rise to overestimates of excess profits, which is disadvantageous to the firms. In so far as these biases were judged to be slight, the use of a domestic version of the CAPM and use of a WACC estimate from the high end of the range could be considered to be compensation for them.

In respect of the costs of financial distress, the situation in principle is similar to that of asset stranding and natural disasters. Even in the event that firms have raised their prices ex-ante in compensation, and a regulator was able to assess any costs of this type that were actually incurred, no convincing evidence is available that the appropriate ex-ante adjustment to output prices is substantial. Accordingly, I favour no increment 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 CAPM is advantageous to firms, and the recommendation to use a WACC estimate from the upper end of the suggested band is likely to be advantageous to them.

Finally, in respect of timing options, firm resource constraints, and information asymmetries, I do not consider in principle that any adjustment to WACC is warranted for the purpose of assessing excess profits.

1. Introduction

The Commerce Commission has recently commenced an investigation into the question of whether gas pipeline businesses (transmission and distribution) should be subject to increased regulatory control. In particular, they will be assessing whether "control" should be declared. Inter alia, this may involve determination of an efficient level of revenue, i.e., a level that reflects efficient costs and an appropriate Weighted Average Cost of Capital (WACC) for these businesses. The purpose of this paper is to assess this WACC.

Section 2 of this paper presents a framework for determining nominal WACC, and the following sections then discuss and estimate relevant parameter values. In particular section 3 estimates the market risk premium, section 4 the risk free rate, section 5 asset betas, section 6 leverage, and section 7 the debt risk premium. Section 8 then assesses whether the form of ownership of the gas pipeline businesses is relevant to the methodology used in estimating WACC. Section 9 then presents WACC estimates, based on the current risk free rate. Section 10 compares nominal and real WACC approaches. Finally, section 10 assesses whether various non-WACC issues can and should be accommodated through an adjustment to the WACC.

2. The Choice of Model

The process involved here bears a strong similarity to the Commission's examinations in respect of airfield operations and electricity lines businesses (Commerce Commission, 2002a, 2002b). The same nominal WACC model is recommended here. In particular

$$WACC = k_e(1-L) + k_d(1-.33)L \qquad (1)$$

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.,

$$k_d = R_f + p \qquad (2)$$

In respect of the cost of equity, this is estimated from 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 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 New Zealand and elsewhere. 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 (Lally, 2001a), most of the parties to the inquiry into lines businesses (Lally, 2003a), and one of the two parties making submissions on this issue in respect of the gas pipelines inquiry.

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).

Across the submissions presented to the Commission in the airfields, lines business and gas pipeline inquiries, the only significant deviations from the above model were in respect of equation (3). In particular, PricewaterhouseCoopers, hereafter PwC (2003a), have argued for recognising capital gains tax 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 of about 25% of the ordinary tax rate (Lally, 2000; Lally and Marsden, 2003a). However the effect on the estimated WACC is slight[1]. 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

[1] 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 of assuming a higher capital gains tax rate is to increase the estimated WACC. For example, with an equity beta of .83 as suggested later in this paper (based on an asset beta of .50 and leverage of .40), and a risk free rate of .051, the effect of assuming an average tax rate on capital gains of 25% of the ordinary rate rather than zero is to increase the estimated WACC by less than .05%.

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 (2003a), 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[2]. In view of all this, the assumption of a current average (across equity investors) marginal tax rate on ordinary income of .33 is favoured.

In addition, NECG (2003) argues for using the Officer version of the CAPM, on the grounds that it is used by regulatory bodies in Australia. However, at some point, the merits of a model must be addressed. As indicated above, equation (3) is clearly a better reflection of the personal tax regime operating in New Zealand than the Officer version of the CAPM, because the latter assumes that interest and capital gains are equally taxed and this is not a good characterisation of the New Zealand taxation regime.

Although there are no other explicit arguments for an alternative version of the CAPM, NECG (2003) do reject the use of historical New Zealand data for estimating the market risk premium, on the grounds that it reflects segregation of the New Zealand market from international capital flows, and this segregation no longer applies. It is implicit in this comment that an international version of the CAPM might be more appropriate than equation (3). Equation (3) assumes that national share markets are fully segregated whereas international models assumes complete integration. As noted earlier, the truth is clearly between these two extremes.

[2] As with the examination of the capital gains tax issue in footnote 1, the effect on the estimated WACC from variation in the assumed ordinary tax rate depends 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 the ordinary tax rate is nil, due to the offsetting effect in the market risk premium. With a beta less than one, the effect is to reduce the estimated WACC. For example, with an equity beta of .83 as suggested later in this paper (based on an asset beta of .50 and leverage of .40), and a risk free rate of .051, the effect of raising the assumed ordinary tax rate from 33% to 39% is to reduce the estimated WACC by less than .05%.

Furthermore, 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. Accordingly, the use of a domestic model like that in equation (3) rather than an international model is favoured. Having said this, it should be noted that use of a domestic rather than an international model for New Zealand assets is likely to produce a higher estimate of the cost equity, both because of higher betas and a higher market risk premium (see Lally, 1998c). Accordingly the use of (3) should produce an estimate of the cost of equity that is biased upwards.

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, and survey evidence. The pros and cons of these approaches are discussed in Lally (2001a). Since all of them have their limitations, consideration of the entire set of approaches is advisable. In addition, purely New Zealand data may be objected to on various grounds, so there are advantages to considering results from other markets.

We 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. 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[3]. Finally, they assume that the relevant ordinary

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

personal tax rate is simply the top statutory rate, whereas Lally and Marsden 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 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. Correcting these numbers, for consistency with the tax assumptions of equation (4), the result is .056-.063.

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, Credit Suisse First Boston (1998) obtained an estimate of .075, and the estimates over the preceding few years generated an average that was similar to this. However, these estimates do not reflect the taxation assumptions of equation (4), most particularly a value for T_I of .20 rather than .33[4]. Given a ten year risk free rate of around .06 in 1998, the implied value for the market risk premium in equation (4) is about .083.

[4] 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.

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. 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 (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, then these estimates of the market risk premium will be biased up[5]. Other variants on the forward-looking approach have been applied in other markets, but not yet in New Zealand.

The final approach considered is that of survey evidence. Lally, Roush and van Zijl (2003) 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 current ten year government stock rate of .055, 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.

[5] The long run growth rate in dividends per share (of existing companies) cannot exceed that for aggregate dividends in existing companies, which cannot exceed the long run growth rate for the aggregate dividends in all New Zealand 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.

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 rate would presumably have been higher and therefore the Ibbotson-type estimate of the market risk premium may have been lower[6]. 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[7]. Converting this figure to an estimate of the market risk premium in equation (4), using the current New Zealand ten year government stock rate of .055 (July 2003 average), yields an estimate of .087. 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. Using the same conversion to equation (4), the result is .084.

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

[6] 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.

[7] 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.

.03-.04, and the midpoint of .035 is adopted[8]. The resulting Siegel estimate of the standard market risk premium for the US is .055. Converting this figure to an estimate of the market risk premium in equation (4), using the current New Zealand ten year government stock rate of .055, yields an estimate of .073. 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 .035. The median Siegel-type estimate for the standard market risk premium is then .046. Using the standard conversion to equation (4), the result is .064.

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 a current New Zealand ten year risk free rate of .055 (July 2003 average), this implies an estimate for the market risk premium in equation (4) of .063.

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 than short-term bonds[9]. 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

[8] 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 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.

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

the market risk premium, using a current New Zealand ten year risk free rate of .055 (July 2003 average), this implies an estimate for the market risk premium in equation (4) of .053. In addition, Graham and Harvey (2001, Figure 3) survey US CFOs and report a median estimate of .040 defined relative to ten year bond yields[10]. Corrected for the difference in definitions, this implies a estimate for the market risk premium in equation (4) of .058.

3.2 Conclusions

To summarise the results in the previous section, the New Zealand results are .073 for the Ibbotson approach, .056-.063 for the Siegel approach, .083 from the Merton approach, .054-.075 for Cornell's forward-looking approach, and .073 (.088) from survey evidence from academics (practitioners). The corresponding US results are .087 from the Ibbotson approach, .073 from the Siegel approach, .063 from Cornell's forward-looking approach, and .053 (.058) from survey evidence from academics (practitioners). In respect of other foreign markets the results are .084 for the Ibbotson approach and .064 for the Siegel approach. 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 results in ascending order are as follows.

New Zealand	.059, .064, .073, .080, .083	(median = .073)
US	.055, .063, .073, .087	(median = .068)
Other	.064, .084	(median = .074)

The appropriate weightings for these three sets of results are unclear. In respect of the New Zealand results, the Ibbotson-type result is subject to the pre 1985 data problems referred to earlier. In respect of the US results, US data is less relevant because some of the underlying variables that drive market risk premiums differ across the two markets. In particular, 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

[10] Their Figure 3 reports results for a series of surveys over time, with median estimates ranging from .032 to .045. The median of this set is .040.

return on equity, and therefore raise the market risk premium. Finally, in respect of the other foreign results, 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.

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 current differential between New Zealand five and ten year bond yields (.004), the estimate of the market risk premium would rise by .003[11]. Thus, the medians for the New Zealand, US and other markets would rise to .076, .071 and .077 respectively. If the two year risk free rate was used then, by the same reasoning, the estimate of the market risk premium would rise by a further .001. Such adjustments are not inconsequential, but are indicative only 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. 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[12]. In addition, the forward-looking estimates presented are biased up for reasons indicated earlier, and 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

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[11] Such a correction will only be appropriate for the forward-looking and survey methods. In respect of the US results, the correction would be of the same type and would raise the risk free rate by .005 (March 2003 mean: data from the Federal Reserve website), yielding the same increment of .003 in the estimate of the market risk premium. I am unable to adjust the results for the other methods.

[12] 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.

against long-term bonds), Claus and Thomas (2001), who obtain .034, and Jagannathan et al (2001), who obtain .013.

Taking account of all this, and my belief that accuracy in this area is attainable to no more than two decimal points, I favour an estimate of .07, with bands from .06 to .08. This judgement corresponds to that recently offered in respect of the lines companies (Lally, 2003a), and contrasts with the estimate of .08 offered earlier in respect of airfield activities (Lally, 2001a). The latter difference is attributable to additional estimates becoming available in the intervening period, and is discussed in Lally (2003a).

This estimate of the market risk premium is obtained using data available at the present time. If one estimates the WACC for earlier years, the question of whether this estimate for the market risk premium is equally applicable to these earlier years arises. Of the estimation methods used, 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, LECG (2003a) have argued for a higher estimate of the market risk premium than .070. In particular, they argue for an estimate of .090, on the grounds that the Ibbotson approach 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 Dimson et al (2002, Table 12-2) estimate of the US market risk premium in the standard CAPM, using geometric differencing, of .070. This is converted to 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 concerned with electricity lines businesses, but with implications for the current inquiry, they lower their estimate of the US market risk premium to .064, and therefore that for New Zealand to .085 (LECG, 2003d)[13].

There are a number of difficulties in these arguments. First, the adjustment to the market risk premium in equation (4) involves an increment of .018 rather than .021, and the resulting estimate for equation (4) is then .082 rather than .085. Secondly, they invoke results from Dimson et al (2003) that involve geometric rather than arithmetic differencing of annual returns, and the former is inconsistent with the definition of the market risk premium. Thirdly, and more significantly, LECG do not acknowledge any deficiencies in the Ibbotson methodology (see Lally, 2001a). In my view all approaches to estimation are imperfect, and this argues for considering all of them. Even leaving aside the New Zealand data that I have drawn upon, examples of US studies that yield significantly lower estimates of the US market risk premium (defined against long-term bonds) than the .064 recommended by LECG (2003d) are 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 .040 (defined against long-term bonds, as derived earlier). LECG give no weight to these results.

Similar to LECG (2003a, 2003d), NECG (2003) also argue for estimating the market risk premium using the Ibbotson methodology along with US data, but subject to corrections for differences between the US and New Zealand markets and for the version of the CAPM used. However, a numerical estimate is not offered. Their argument for rejecting historical New Zealand data is that it reflects segregation of the New Zealand market from international capital flows, and this segregation no longer applies. However, the logical conclusion to draw from this observation is that the appropriate CAPM to use is an international rather than a domestic one, and the effect is likely to lower the cost of equity. They also argue that forward-looking approaches to estimation of the market risk premium are flawed, on the grounds that they generate a range of estimates. However, they do not acknowledge the difficulties with

[13] The lower US figure reflects more recent data from Dimson et al (2003).

Ibbotson estimates based on even US data (outlined in Lally, 2001a). My view is that all approaches have their drawbacks, and therefore a wide range of alternative approaches should be considered.

In a recent submission relating to the lines businesses, but with implications for regulatory behaviour in general, 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. However it is not unusual for parameter estimates to have this characteristic. 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.,

$$MRP = \lambda Var(R_m) \quad (6)$$

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.,

$$MRP = \lambda Cov(C, R_m) \quad (7)$$

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.

There are a number of difficulties with this sophisticated line of argument. First, equations (6) and (7) cannot both be true. Equation (7) arises from a world in which investors care about future investment opportunities whereas equation (6) arises from one in which they do not, i.e., they act *as if* the world is a single-period one. The CAPM version invoked earlier in equation (3) is of the single-period type, and this appears to rule out equation (7). Whether equation (3) is correct is a quite separate matter, and has been discussed earlier. Furthermore, even if one chose to invoke the estimate from equation (7), it would have to be inserted into the consumption CAPM rather than equation (3).

Secondly, and in respect of equation (6), the two parameter estimates underlying the figure of .30 presented by LECG are arguable[14]. 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 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 .083[15]. 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. Using an estimate for the market variance of .04 and one for λ of 2, the market risk premium would then fall from LECG's figure of .30 to .08. Thus, if equation (6) is employed, it would appear to admit a wide range of possible results. This warrants caution in placing any weight upon the results; LECG (2003d, p 4) appear to concur with this general principle.

[14] 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.

[15] 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.

Thirdly, 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 it. In respect of past average returns, Lally and Marsden (2004a) present an estimate based on this of .073 with a standard error on it of .028. 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. This is simply inconceivable.

Having said all this, there is no doubt that estimation of the market risk premium is difficult. My judgement that the bounds on the value should be .06-.08 was not intended to indicate that there is no chance of the true value lying beyond these bounds, or even that the chance is slight. Instead, my intention was to offer a range of numbers that are readily reconcilable with the majority of the empirical evidence, subject to my belief that precision beyond the second decimal point is unattainable. Thus, if the bounds were to be expanded, they would become .05-.09, and neither of these two numbers can be readily reconciled with the range of estimates presented in section 3.2. In particular, both numbers lie outside the range of those estimates.

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 data should be current but the use of the rate on a single day (or less) yields exposure to a freakish rate, due to the volume of trades or to trades motivated by particularly strong incentives to transact. Accordingly, I favour averaging of the rate over the preceding month. NECG (2003) argues instead for the rate on a single day. Their rationale seems to be that the appropriate rate is that at a point in time. In this event one should choose the last transaction on a particular day. Thus the act of using even a daily rate involves a degree of averaging. The debate then seems to be merely about the degree of averaging. In my view, use of a daily average generates too much exposure to a freakish rate.

Turning to the choice of term, the assessment of excess profits over a particular period might suggest that the appropriate term for the risk free rate matched that review period. However, as shown in Lally (2002a), the appropriate term is that ensuring that the present value of the future cash flows equals the initial investment, and this implies that the appropriate term is that matching the period for which output prices are set. This is quite distinct from the period over which excess profits will be assessed.

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, reflecting the presence of either formal or informal understandings on this question (Lally, 2001a). In respect of the lines businesses, no conclusion was reached, as there has been neither explicit regulation nor even informal understandings as to the frequency with which prices are reset (Lally, 2003a). The situation for the gas pipeline businesses seems to be as unclear as that for the lines businesses. The feasible candidates for the frequency with which prices are reviewed are in the 1-5 year range, and I therefore suggest the midpoint of three years. So, this points to using the three year risk free rate. This would be set at the beginning of the review period (i.e., the month preceding it), and then reset in three years at the three year rate prevailing at that time, and so forth.

A widespread, and contrary, view is that the choice of the risk free rate term should be based on the duration of the firm's assets (NECG, 2003; LECG, 2003a). However, to support any conclusion in this area, it is necessary to show that the resulting present value of the future cash flows matches the initial investment (as in Lally, 2002a, 2002c). None of the presentations of this contrary line of argument shows that their preferred term for the risk free rate satisfies this requirement. That the choice of the risk free rate should be governed by the frequency with which prices are reset, rather than according to the duration of the firm's assets, can be demonstrated through an example appearing in Lally (2001a). Suppose that the period for which prices are set is five years commencing now, i.e., from time 0 till time 5. In five years, prices will be reset then for a further five years, and so on. The duration of the firm's assets is ten years. Also, suppose that the five year bond rate is currently 5% and the ten year bond rate is currently 7.5%, the latter due to expectations that interest rates in five years will be 10%. Suppose these expectations are certain to be vindicated, i.e., in 5 years, the bond rate will be 10% for all terms to maturity. If prices were set using the risk free rate matching the period for which prices are fixed, then a rate of 5% would be used for the next five years, followed by the use of 10% thereafter. By contrast, if prices were set using a rate matching the asset duration, the rate used would be 7.5% for the first five year period, followed by 10% thereafter. The latter approach then leads to double-dipping in the sense of the firm being rewarded for future high interest rates not only when they occur but also in anticipation of it.

Another widespread, and potentially contrary, view in this area is that the risk free rate used here should match that used in estimating the market risk premium (LECG, 2003a; NECG, 2003). 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 regulatory 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 conclusion presented above, 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 regulatory 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 regulatory 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 the previous section, 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 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.

In summary then, the argument for consistency is flawed. Furthermore, if consistency is to be imposed, then it would have to be done through adjusting the risk free rate used in estimating the market risk premium, and this is precluded by data limitations. Accordingly, the consistency argument is not favoured. The risk free rate appearing as the first term in equation (3) should be the three year rate, and the risk free rate used in estimating the market risk premium should be the ten year rate.

Having suggested the use of the three year risk free rate for the first term in equation (3), with averaging over a period of one month, it may be useful to consider the results from doing so at the present time. The two and five year rates averaged over the month of July have been 4.90% and 5.08%[16]. These numbers reflect simple interest rather than compounding over six month periods, and correction for this yields 4.96% and 5.14%. Using linear interpolation, the implied three year risk free rate is then 5.02%.

5. Asset Betas

5.1 Underlying Factors

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

The first factor is industry, i.e. the nature of the product or service. Firms producing products with low income elasticity of demand (necessities) should have lower sensitivity to real GNP shocks than firms producing products with high income elasticity of demand (luxuries), because demand for their product will be less sensitive to real GNP shocks[17]. Rosenberg and Guy (1976, Table 2) document statistically significant differences in industry betas after allowing for various firm specific characteristics, and these differences accord with intuition about the income elasticities of demand. For example energy suppliers have particularly low betas whilst recreational travel is particularly high.

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

[16] Data from the Reserve Bank website.

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

demand from foreigners tends to reduce the asset beta[18]. A third aspect of customer composition is the personal/business mix, and the former may be less sensitive to GNP shocks in the case of gas pipeline businesses[19].

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 gas pipeline 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 firm might increase its output price. However an output price that is contractually fixed for some period prevents a firm from immediately acting in that way, and thereby reduces the firm's beta. By contrast, in the presence of an adverse cost shock (which induces an adverse economy-wide reduction in output), the same restriction on output price also prevents a firm from immediately raising its output price to mitigate the adverse cost shock, and this magnifies its beta[20]. In respect of the gas pipeline businesses, long-term contracts exist with some of their customers, and in some cases with their suppliers.

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

[18] This is due to their demand having 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.

[19] This would be true if gas constituted an "essential" product to consumers (whether consumed directly or indirectly through its conversion to electricity). By contrast, business demand for gas constitutes intermediate demand, whose sensitivity to GNP shocks will be driven by the sensitivity of consumers' demands for the final products in question. A clear contrary case is air travel, in which the personal demand for it would have greater sensitivity to GNP shocks than business demand, because personal consumption of it is a luxury.

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

such industries have amongst the lowest betas after allowing for various firm specific variables. However, as the reset interval increases, the adjustment of the output price so as to preserve the firm's rate of return is increasingly delayed; exposure to macro-economic cost shocks then increases, and this should raise the firm's beta as the reset interval increases. 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 greater average asset betas than for utilities subject to US style regulation (in which prices are set for only one year). Lally (2002b) attributes part of the difference in asset betas to market leverage differences, but this still leaves a substantial residue, apparently attributable to the difference in regulatory 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 gas pipeline businesses, there are no price controls in force. However they have operated for some time in the knowledge that excess profits might induce price controls. Thus they face a quasi-regulatory regime.

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 gas pipeline businesses, they seem to be local monopolists but their monopoly power may be diluted by the countervailing power of their large customers and the presence of competing power sources. So, if monopoly power affects beta, then the effect of any such countervailing power and competing energy sources would be to mitigate that beta effect.

The seventh factor is the extent of the firm's real options, most particularly the option to adopt new products. Myers and Turnbull (1977, pp. 331-2) note that the betas of firms will diverge from those of their individual projects if the firms have growth options. The existence of such growth options should increase the firm's sensitivity to real GNP shocks, as the values of these growth options should be more sensitive to real GNP shocks than the 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, gas pipeline businesses do not have significant growth options.

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, since the gas pipeline businesses seem to exhibit significant local monopoly power, then the situation would seem to correspond more closely 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. Gas pipeline businesses and possible comparators have very limited weights in market indexes[21]. Consequently this point is irrelevant.

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 respect of the firms themselves, only two of them are currently listed companies (PowerCo and NGC) whilst a third (United Networks) was listed until the end of 2002 (at which point the assets were split between PowerCo and the newly formed Vector). Furthermore, such beta estimates could only be used for the period since their energy businesses were sold, i.e., from 1999. In view of all this, their equity betas β_e are estimated by OLS regression against the NZSE40 gross index for the period Jan 2000 – Jan 2003, yielding the results shown in the table below. These figures must be stripped of leverage to yield estimates of the asset betas β_a. Equation (5) formalises the relationship between equity and asset betas, but it is only valid at a point in time. However the equity betas are estimated over a period of three years, and therefore

[21] In respect of New Zealand, the current weight of gas pipeline businesses in the NZSE40 index is under 5% (data from the NZX). This weight comes from NGC and PowerCo, whose aggregate weight is under 5%, and which are engaged in activities other than gas transmission and distribution.

reflect average debt/equity levels (B/S) over that period rather than current leverage[22]. The debt/equity levels for each firm, for each of these three years and the average, are shown below[23]. Substitution of these estimated equity betas and average debt/equity levels into equation (5) then yields the following asset betas.

		B/S				
Company	β_e	2000	2001	2002	Mean	β_a
PowerCo	.96	.89	.96	1.13	.99	.48
United Networks	-.20	1.13	.69	.72	.85	-.10
NGC	.27	n/a	n/a	.52	.52	.18

The average of these asset betas is .19. However, in view of the small number of companies, and the fact that even during this three year period they were engaged in activities other than gas transmission and distribution, no great reliance can be placed upon this average of .19.

I turn now to an examination of comparable companies. If the gas pipeline 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 firms in the gas distribution sector, which are subject to rate of return regulation with annual resetting of prices. Damodaran (2003) offers an estimated average asset beta of .37 for these US firms[24]. However this estimate reflects market leverage and the tax environment in the US rather than for New Zealand. The adjustment formula is detailed in Lally (2002b), and requires knowledge of market leverages and tax parameters in the two markets. Furthermore, Lally (1998a) shows that the relevant US parameter values are the averages over the beta estimation period, along with current values for New Zealand. Recent estimates for the leverages of the two markets are .26 for the US and

[22] 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.

[23] 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 time the debt levels are observed).

[24] The estimate is an average over 32 firms, with equity betas estimated from standard OLS regression s involving the previous five years data (with no adjustments), followed by degearing using the Hamada (1972) formula.

.19 for New Zealand (Ernst and Young, 2000). In addition, the relevant tax parameters are .34 for the US (the corporate tax rate) and zero for New Zealand (due to dividend imputation). The asset beta estimate of .37 is then converted to a New Zealand equivalent of

$$\beta_a = .37 \frac{\left[1 + \frac{.26}{(1-.26)}(1-.34)\right]}{\left[1 + \frac{.19}{(1-.19)}(1-0)\right]} = .37$$

Estimates of this type are subject to estimation error, and therefore one should weight the results from a variety of periods. Damodaran (1998) also offers an average estimate reflecting data over the period 1994-98, and Alexander et al (1996, Appendix A2) offer an average estimate based on the period 1990-94. These numbers are shown in the second column of the table below. Again, the conversion to New Zealand is required, and requires knowledge of US average market leverage over the beta estimation period. Fama and French (1999, Figure 1) give US market leverages for each year in this period, and the averages are indicated in the third column below. The fourth column shows the US corporate tax rate, the fifth column shows the recent estimate of New Zealand market leverage, and the last column shows the asset beta estimate appropriate to New Zealand (generated using the above formula).

Period	β_a^{US}	L_{US}	T_{US}	L_{NZ}	β_a^{NZ}
1990-1994	.20	.34	.34	.19	.22
1994-1998	.46	.27	.34	.19	.46
1999-2003	.37	.26	.34	.19	.37

The average of the numbers in the last column is .35. All of this suggests an asset beta for the US rate of return regulated gas distribution businesses of around .35. Of course, the New Zealand gas pipeline businesses do not face explicit price controls, let alone annual price resetting. 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 raise their asset betas. Thus, the US estimate of .35 should be seen as a lower bound on that of the New Zealand firms.

A second useful comparator is UK price regulated gas distribution firms, with five yearly price resetting[25]. Unfortunately, Alexander et al (1996) indicates only one such listed firm in the UK in the period examined (1990-94), and this is insufficient to draw any conclusions from. Nevertheless, the earlier discussion suggests that the longer regulatory cycle for these firms relative to the US ones should have induced an increase in the asset beta. Lally (2003a, p 26) estimates the increment for electricity distribution firms at .10-.20, and this could reasonably be extrapolated to gas pipeline businesses. In comparing the New Zealand gas pipeline businesses with counterparts subject instead to a five year price cap, the latter firms would be unable to raise their prices within the five year regulatory cycle in response to cost increases, and this fact would have led to them having higher asset betas than the New Zealand firms. By contrast, the New Zealand firms would face less exposure to demand shocks and this would imply lower asset betas. In addition, firms subject to a five year price cap would also be subject to regulatory errors, some of which may have increased their asset betas[26]. Firms subject to a five year price cap would also have been less likely to have lowered their output prices within the regulatory cycle so as to conform more closely with costs (because the regulatory design clearly encouraged the earning of excess profits within the regulatory cycle, subject to the price cap); this is likely to have increased their asset betas relative to the New Zealand firms. Taking account of these various factors, my judgement is that subjecting the New Zealand firms to a five year price cap would have raised their asset betas.

[25] 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 gas pipeline businesses are not useful comparators because they are also revenue capped (ACCC, 1999).

[26] 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.

In conclusion then, examination of the above comparators suggests that the asset betas of the New Zealand gas pipeline businesses should lie between the estimate for the US firms and the estimate appropriate under a five year price cap regime. The former is estimated at .35 and the latter at .10-.20 larger. This points to an estimate of .35-.55 for the New Zealand gas pipeline businesses. However the base figure here of .35 is based purely upon the US statistical data presented earlier, and the variation in results from the three periods examined there suggests that there is a non-trivial margin of error. Accordingly, it is appropriate to compare the suggested result here with those from the Commission's earlier investigations into lines businesses and airfield operations.

In respect of the lines businesses, a range of .30-.50 was suggested (Lally, 2003a), whilst a range of .40-.60 was suggested for the airfield operations (Lally, 2001a). Lally (2003a) explains this difference in terms of the factors that underlie asset betas, and described earlier in section 5.1. In particular, airfield operations were judged similar to the lines businesses in respect of all explanatory factors except the following two. First, involving 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. Secondly, 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. Lally (2002d) provides theoretical support for modest adjustments to the asset beta in the presence of frequent price resetting to recover cost increases.

Turning now to the gas pipeline businesses, the gas pipeline and electricity lines businesses are also similar in respect of most of these factors underlying asset betas. In particular, they are similar in their pricing structure (fixed plus variable), in their exposure to a "regulatory" threat, in the extent of their real options, in their operating leverage, and finally in both sectors being a small proportion of the market index. The situation regarding monopoly power is less clear. The remaining two factors are the nature of the product and the composition of customers, and here there are three potentially significant differences. First, unlike electricity, which is used exclusively as a power source, a large proportion (30%) of gas is used as an intermediate product in the petrochemical industry, in particular for the production of methanol (Ministry of Economic Development, 2004, p 86). This points to a higher income elasticity of demand for gas, and therefore for pipeline services. Accordingly the asset beta should be higher than for lines businesses. However, there are two mitigating factors here. First, virtually all the methanol is exported[27]. This fact will lower the correlation between the demand for this product and the return on the New Zealand market portfolio. Thus, the impact of gas being used in methanol production upon the asset beta of the pipeline businesses will be mitigated. Secondly, despite the fact that 30% of the gas is used in the petrochemical industry, very little revenue arises from this, because the distance that it is piped is relatively short. Since the revenue contribution is small, the impact upon the overall asset beta will also be small.

The second possible point of distinction between the gas pipeline and electricity lines businesses is that, whilst a large proportion of gas is used in the generation of electricity, some of it is used to generate the variable rather than the base supply. If the extent of this variable supply were substantial, then the demand for gas would be more sensitive to macro economic shocks than the demand for electricity and this would point to a higher asset beta for the gas pipeline businesses than that for the electricity lines businesses. However, most of the gas used for electricity generation is supplied to the Otahuhu, TCC and Huntly plants (Ministry of Economic Development, 2004, p 86), and these plants generally provide base rather than variable supply. So, this issue does not point to any significant increase in the asset beta for gas pipeline businesses.

The third point relates to the use of gas by residential or commercial users. Leaving aside the gas used by the petrochemical industry, 30% of gas is directly supplied to commercial and industrial users, with a further 64% used for generating electricity (ibid, p 86). Of this electricity generation, 68% is supplied to commercial and industrial users (ibid, p 106). The overall use of gas by these users is then 74% [30% + .64(68%)]. Inclusion of the gas supplied to the petrochemical industry raises the figure from 74% to 82%. By contrast, only 68% of electricity generation is supplied to commercial and industrial users. The supply of gas or electricity to commercial and industrial users constitutes an intermediate product whose demand will be driven

[27] A figure of 98% is reported on the website of Methanex New Zealand (www.methanex.com/ourcompany/locations_newzealand).

by the demand for the final goods and services. The demand for these final goods and services is likely to be more sensitive to macro economic shocks than the demand for gas or electricity by residential users. So, with gas supply more heavily tilted towards commercial and industrial users than for electricity, the demand for gas is likely to be more sensitive to macro economic shocks. This implies a higher asset beta for the gas pipeline businesses than for the electricity lines businesses.

Taking account of these three points, particularly the latter one, the gas pipeline businesses would seem to warrant a modestly higher asset beta than the lines businesses. I therefore suggest an asset beta for the gas pipeline businesses of .40-.60, with a point estimate of .50. The range here will reflect the extent to which the gas pipeline businesses operate in a cost-plus fashion. Those operating in a highly cost-plus fashion would have asset betas towards the lower end of the scale, and those with significant ownership by local councils and community trusts might be of this type. However, quantifying any such effect upon beta would seem to be impossible to attain.

The analysis here leads to the same asset beta for both transmission and distribution. However there are some possible points of difference in these two activities that are suggestive of differences in beta. In particular, transmission may be characterised by less competition. However the effect of competition upon beta is unclear, as discussed earlier in section 5.1. So, in light of these difficulties, the same asset beta is applied to both transmission and distribution.

5.3 The Effect of Asset Valuation Methodology

The analysis so far has paid no account of asset valuation methodology, and the impact this might have upon the asset beta. There are two potentially distinct issues here. First, the output prices of firms (and therefore their asset betas) are affected by their assessment of costs, and therefore by the asset valuation methodology. This is transparent in the case of regulated firms (such as the US and UK gas distribution firms which are used as comparators), but is also relevant to the New Zealand firms. If the asset valuation methodologies differ then issues of comparability in their asset betas arise. Secondly, in respect of the Commission's ex-post assessment of excess profits, the choice of asset valuation methodology affects the assessment of excess profits. As discussed in Lally (2002e), the Commission's choice of asset valuation methodology for depreciating assets (most of the pipeline businesses' assets are of this type) should accord with that used by the businesses in setting their own output prices. So, in respect of both issues, asset valuation methodology may affect asset betas simply because it underlies output prices.

The range of asset valuation methodologies to consider here comprises historic cost, inflation-adjusted historic cost, replacement cost, optimised replacement cost (ORC), and optimised deprival value (ODV)[28]. Historic cost characterises the US firms, inflation-adjusted historic cost characterises the UK firms, and the other three may underlie the output pricing for the New Zealand firms. The points of distinction are threefold: CPI inflation, asset specific inflation, and optimisations. Historic cost is subject to none of them, inflation-adjusted historic cost to the first, replacement cost to the first two, and ORC to all three. The act of optimising assets out introduces risks to the firm, but the risks would be industry specific at most, i.e., this would not be a market-wide risk. So, the asset beta would be unaffected. In respect of asset specific inflation, again this would not appear to be a market-wide risk and therefore the asset beta would be unaffected[29]. Accordingly the asset beta of the firm would be unaffected. This leaves CPI inflation, which affects asset values under the inflation-adjusted and replacement cost methods. Lally (2002c) examines this issue and concludes that its effect upon asset values and therefore output prices would tend to reduce beta (providing that the CAPM was framed in nominal rather than real terms, which is conventional). The intuition is that higher CPI inflation raises asset values, and therefore the present value of the entity's future cash flows, whilst being associated with low stock market returns (Fama and Schwert, 1977; Fama, 1981; Chen, Roll and Ross, 1986). Consequently, the firm's rate of return would be negatively correlated with stock market returns[30]. This implies that the firm's

[28] The ODV methodology is essentially the same as ORC.

[29] It could be argued that exchange rate movements are a market-wide risk and asset specific inflation is sensitive to this. However, the extent to which this is true is unclear.

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

nominal returns are negatively correlated with nominal stock market return[31]. However the analysis in Lally (2002c) suggests that the scale of the effect is modest. Accordingly, no adjustment is warranted. In summary then, any variation in asset valuation methodology should not have a material effect upon the asset beta.

5.4 Contrary Views

A number of submissions by or on behalf of the gas pipeline businesses have argued for a higher value for the asset beta than suggested above. On behalf of NGC, LECG (2003a) argue for a range of .45 to .65 with a point estimate of .55. This point estimate appears to be based on an asset beta for US electric utilities of .35, an increment of .10 to allow for the difference between the New Zealand and US regulatory situations, and an increment of .10 to allow for the difference between electricity distribution and gas pipeline businesses. The only point of difference here concerns the US electric utilities, and is modest.

On behalf of PowerCo, LECG (2003c) also argue 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). They concur with my estimate of .48 obtained solely from PowerCo's returns data (see section 5.2), but add that this is likely to be biased because it is estimated against a "market" portfolio that includes only equities rather than equities and risky debt. In particular, they argue that it will be biased down for reasons articulated in Ferguson and Shockley (2003). There are a number of difficulties in these arguments. First, the use of returns data from only one firm exposes one to enormous estimation errors. These are illustrated in section 5.2, where the estimates for the three New Zealand firms were .48, -.10 and .18 for PowerCo, United Networks and NGC 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. To further illustrate the point, the asset beta estimated from PowerCo's own returns data could very well have generated a result 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

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

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, 2002b, 2003b). 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 average so obtained of .19 (see section 5.2) is hardly one that would appeal to PowerCo.

Secondly, the bias argument that is attributed to Ferguson and Shockley 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, 1995a, 2002f). 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 gas pipeline businesses, the downward effect upon the market risk premium may offset it. In any event, the point is simply moot because the lack of data on risky debt precludes incorporation of it into a proxy for the market portfolio.

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 based on an ex-post analysis, the choice must lie between the first two. If a business' 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. Since efficient costs are suggested in the Draft Framework Paper (Commerce Commission, 2003, p 7), this suggests the use of optimal leverage.

The optimal leverage level 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 section 5.2 indicates an average of 44%. 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 relatively stable cash flows. In respect of airfields, a figure of 25% was employed in the Airfields Report (Commerce Commission, 2002a). In addition, Lally (2003a, p 25) estimates an average for three listed lines businesses of 45%, although these firms markedly overlap with the gas pipeline businesses examined earlier. By way of comparison, the average leverage of New Zealand firms is around 20% (Ernst and Young, 2000). In view of all this, I recommend a leverage level of 40%. Fortunately one does not need to assess this level with great precision because the effect of such variations in leverage (along with the associated debt premium) on WACC is modest when the tax-adjusted version of the CAPM is employed (see Lally, 1998b)[32].

In respect of contrary submissions, LECG (2003a) argue for leverage of 55%, on the grounds that the company intends to adopt that level of leverage. However, as indicated above, in the context of examining past profits, the choice must lie between actual and optimal leverage during the period examined. Future intentions are irrelevant.

7. The Debt Premium

This is the margin by which the cost of debt exceeds the risk free rate, and may be defined to include an allowance for debt issue costs. The premium was set at .01 for the airfields, and .012 for the lines businesses. Such premiums are towards the low

[32] This point is quantified in the next section.

end of the range for this parameter, in recognition of levels of operating risk that almost precluded bankruptcy[33]. Such low operating risk in turn springs from the essential nature of the products and the monopolistic nature of the industries. Gas pipeline businesses appear to be similar to the airfields and the lines businesses in the latter two senses. In addition, the suggested leverage of 40% for the gas pipeline businesses is comparable to that assumed for the lines businesses, and higher than the 25% assumed for the airfields. All of this suggests that the debt margin should be similar to the .012 margin allowed for the lines businesses.

Further information on this matter comes from recent market trades on non-subordinated bonds, along with current market value leverage. Amongst the gas pipeline businesses, only PowerCo can offer both types of information. Yields to maturity on recent trades (yld) are as follows, along with yields on the same day for government bonds of the same term to maturity (govt)[34]. The margins are thus[35].

	PWC010			PWC020		
	yld	govt	margin	yld	govt	margin
Aug 21	.0650	.0528	.0122	.0690	.0543	.0147
Aug 21	.0675	.0528	.0147	.0700	.0543	.0157
Aug 19				.0685	.0539	.0146
Aug 18	.0650	.0526	.0124	.0690	.0542	.0148
Aug 18				.0675	.0542	.0133
Aug 18				.0660	.0542	.0118

The average of these margins is .0138. In addition the current leverage of PowerCo is 67%[36]. Coupled with the earlier information concerning the lines businesses, this

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

[34] If matching maturity dates cannot be found then interpolation over the range of government bonds is invoked.

[35] Data courtesy of Forsyth Barr.

[36] The current market capitalisation is $544m (NZX website, August 25) and the book value of debt is $1,106m (as per Financial Statements of 31.3.2003).

suggests that, with leverage of 40%, a debt margin of .012 is appropriate for gas businesses.

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[37]. With the WACC governed by equations (1)….(5), WACC can be reduced to

$$WACC = k_u + p(1 - .33)L \qquad (9)$$

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%.

In respect of contrary submissions, LECG (2003a) argue for a debt premium of .02. However the assumed leverage level is 55%, and no supporting evidence for such a margin is offered.

These calculations incorporate no allowance for debt issue costs. These costs could be recognised through WACC or the operating cash flows. However, I consider that allowance for them through WACC is superior, because (like the depreciation on fixed assets) it allocates the costs to all periods rather than concentrating them in the periods in which they are paid. Lee et al (1996, Table 2) suggests an average issue cost for utilities of about 1.3% (by averaging over issues of at least US$40m). Discussion with New Zealand investment bankers indicates similar figures here. Annualisation of this figure requires a bond term. Using a ten year bond term, the equivalent annual figure would be about .20%. If a three year term was used, to match the assumed frequency of price resetting, then the equivalent annual figure would rise to .50%. 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

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

about .30%. Invoking equation (9) above, with leverage of 40%, the effect upon WACC of adding .30% to the debt premium would be less than .10%. This is trivial. 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 presents obvious auditing difficulties. In light of all this, I suggest that no such allowance be made[38].

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 with individual shareholders. However, the ownership of the companies in which the gas pipeline businesses are embedded include councils and community trusts. 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, as follows.

The first of these implications concerns tradability. The ultimate ownership claims over the shares owned by local councils devolve to local ratepayers. In respect of the shares owned by community trusts, the ultimate beneficiaries are even less clear. Neither of these ultimate "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[39]. 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

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

[39] 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.

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. The implications for WACC are that it should be higher. However quantification of the effect does not seem to be possible.

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

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

9. WACC Estimates

Drawing upon the above estimates for various parameters, WACC estimates can now be offered, using equations (1)…(5). The market risk premium ϕ is assessed at .07, with bounds of .06-.08 to reflect uncertainty about the true value of the parameter. Regarding the risk free rate R_f, the suggested rate is the three year one, retrospectively set at the beginning of the assessment period for excess profits, and then reset every three years. The current three year rate (July 2003 average) is .050. The appropriate asset beta β_a for the gas pipeline businesses is assessed at .50, with a range of .40-.60, and with variation according to how closely the business conforms to a cost-plus policy. However, more precision in this area would seem to be impossible to attain. Finally, in respect of leverage L and the associated debt premium p, I recommend values of 40% and .012 respectively for all gas pipeline businesses, in any investigation invoking efficient costs. Should an investigation invoke the actual costs of a firm, then the firm's actual leverage and the associated debt premium should be invoked. These parameter values are now translated into WACC estimates. In particular the lower bound, point estimate and upper bound are as follows.

ϕ	R_f	β_a	L	p	k_e	$WACC$
.06	.050	.40	.40	.012	.073	.061
.07	.050	.50	.40	.012	.092	.072
.08	.050	.60	.40	.012	.113	.085

The presentation of a band gives some flexibility in estimating excess profits. In particular, excess profits could be estimated under all three estimates and a judgement then made as to which of the resulting estimates should be given greatest weight. Given that there is some uncertainty as to the correct parameter estimates, and that the consequences of judging excess profits to exist when they do not are more severe than the contrary error, my view is that one should choose a WACC value from the higher end of the scale. This view about the asymmetrical nature of the errors in assessing WACC is also expressed in LECG (2003a). Further protection against the possibility of using a WACC estimate that is too low comes from the use of a domestic version of the CAPM, which produces a cost of equity that is likely to be too high for reasons discussed in section 2.

10. Real versus Nominal WACC

The analysis so far has yielded a nominal WACC, and this would be used to assess excess earnings defined to include revaluation gains on assets (see Lally, 2003a). One possible difficulty with this approach is the fact that revaluations are volatile and therefore impart volatility to assessments of excess earnings; this in turn gives rise to difficulties in determining whether control is warranted. An alternative approach is to exclude revaluations from earnings, and therefore the WACC used must be real rather than nominal (Lally, 1995b; The Treasury, 1997, Appendix 5). A real WACC is generally defined as a nominal WACC deflated using expected CPI inflation. However we will also consider deflating the nominal WACC using the expected rate of appreciation in the relevant asset price, and designate this as a quasi-real WACC[40]. In choosing between these three approaches, the crucial consideration is whether they give rise to assessments of excess earnings that induce control when control would be unwarranted, or fail to induce control when it is warranted. Following Lally (2003a), it is assumed that regulatory interventions are based upon compounded excess earnings. To assess this issue, four possible scenarios are examined. In all cases, the firm is assumed to set prices by the building block method, so as to merely cover costs. In addition, the setting of prices uses a nominal WACC and incorporates allowance for expected asset revaluations as at the commencement of the project[41]. We start by examining these situations in which excess earnings are assessed through the use of a nominal WACC, and then consider the use of real and quasi-real WACCs.

10.1 Nominal WACC

Case 1: The asset value is expected to inflate at the CPI rate (depreciation aside), and this appreciation rate is realised. In addition, the firm invests $100m in a project with a life of four years, there are no operating costs, depreciation is straight line, the

[40] If the actual rate of appreciation in the asset price was used then the resulting excess earnings would be identical to those arising from using the nominal approach (in effect, actual revaluations would be captured through the "real" WACC rather than in dollar terms). So, we do not need to examine this method as a fourth possible approach.

[41] If the firm set prices using a nominal WACC along with the use of a historic cost asset valuation method, the time profile of revenues would differ but the NPV of the project would still be zero. The complications that arise here in assessing excess earnings are discussed in Lally (2002e) and Lally (2003a).

nominal WACC is 10%, and CPI inflation is 2%. The expected asset values, depreciation and revaluation are then as follows.

Yr (end)	Asset Value	Depreciation	Revaluation
1	$\$100m(.75)(1.02) = \$76.50m$	$\$100m(.25) = \$25m$	$\$1.50m$
2	$\$76.50m(.666)(1.02) = \$52.02m$	$\$76.50m(.333) = \$25.50m$	$\$1.02m$
3	$\$52.02m(.50)(1.02) = \$26.53m$	$\$52.02m(.50) = \$26.01m$	$\$0.52m$
4	$\$26.53m(0) = 0$	$\$26.53m(1) = \$26.53m$	0

Following the building block method, prices are set so that the expected revenues are equal to the nominal cost of capital, plus depreciation, less revaluations, as follows.

$$E(REV_1) = \$100m(.10) + \$25m - \$1.5m = \$33.5m$$

$$E(REV_2) = \$76.5m(.10) + \$25.5m - \$1.02m = \$32.13m$$

$$E(REV_3) = \$52.02m(.10) + \$26.01m - \$0.52m = \$30.69m$$

$$E(REV_4) = \$26.53m(.10) + \$26.53m - 0 = \$29.18m$$

Of course, the present value of these expected revenues, using a discount rate of .10, is equal to the initial investment of $100m, i.e., the NPV is zero. Using the nominal WACC, the excess earnings are revenues less depreciation less the nominal cost of capital plus revaluations. Suppose that expected revenues are in fact realised. In conjunction with an NPV of zero, this implies that the project does not generate excess profits. The excess earnings that are assessed are then as follows.

$$ExcessEarnings_1 = \$33.5m - \$25m - .10(\$100m) + \$1.5m = 0$$

$$ExcessEarnings_2 = \$32.13m - \$25.5m - .10(\$76.5m) + \$1.02m = 0$$

$$ExcessEarnings_3 = \$30.69m - \$26.01m - .10(\$52.02m) + \$0.52m = 0$$

$$ExcessEarnings_4 = \$29.18m - \$26.53m - .10(\$26.53m) + 0 = 0$$

So, the excess earnings that are assessed are consistent with the underlying economic situation of no excess profits.

Case 2: The asset price is now expected to appreciate at a rate other than the CPI rate, and this appreciation rate is realised. In particular, suppose that the asset is expected to decline in value at 1% per year, in addition to the effect of straight line depreciation. The expected asset values, depreciation and revaluations are then as follows.

Yr (end)	Asset Value	Depreciation	Revaluation
1	\$100*m*(.75)(.99) = \$74.25*m*	\$100*m*(.25) = \$25*m*	-\$0.75*m*
2	\$74.25*m*(.666)(.99) = \$49*m*	\$74.25*m*(.333) = \$24.75*m*	-\$0.50*m*
3	\$49*m*(.50)(.99) = \$24.25*m*	\$49*m*(.50) = \$24.5*m*	-\$0.25*m*
4	\$24.25*m*(0) = 0	\$24.25*m*(1) = \$24.25*m*	0

Following the building block method, prices are set by the firm so that the expected revenues are as follows.

$$E(REV_1) = \$100m(.10) + \$25m + \$0.75m = \$35.75m$$

$$E(REV_2) = \$74.25m(.10) + \$24.75m + \$0.50m = \$32.67m$$

$$E(REV_3) = \$49m(.10) + \$24.50m + \$0.25m = \$29.65m$$

$$E(REV_4) = \$24.25m(.10) + \$24.25m - 0 = \$26.67m$$

These revenues differ from those in the first example, but their present value is still equal to the initial investment of $100m, i.e., NPV = 0. As before, we now suppose that expected revenues are realised, so that the project does not give rise to excess profits. The excess earnings that are assessed are then as follows.

$$ExcessEarnings_1 = \$35.75m - \$25m - .10(\$100m) - \$0.75m = 0$$

$$ExcessEarnings_2 = \$32.67m - \$24.75m - .10(\$74.25m) - \$0.50m = 0$$

$$ExcessEarnings_3 = \$29.65m - \$24.50m - .10(\$49m) - \$0.25m = 0$$

$$ExcessEarnings_4 = \$26.67m - \$24.25m - .10(\$24.25m) + 0 = 0$$

Again, the excess earnings that are assessed are consistent with the underlying economic situation of no excess profits.

Case 3: The asset value is expected to appreciate at the CPI inflation rate, but grows more rapidly than this. In particular, the asset value evolves as indicated in the second column below. Actual depreciation then follows in accordance with the straight line rule, and the actual revaluations follow from the asset values and the depreciation.

Yr (end)	Asset Value	Depreciation	Revaluation
1	$80*m*	$100*m*(.25) = $25*m*	$5*m*
2	$60*m*	$80*m*(.333) = $26.66*m*	$6.66*m*
3	$25*m*	$60*m*(.50) = $30*m*	-$5*m*
4	0	$25*m*(1) = $25*m*	0

The expected revenues are as indicated in the first example above, and therefore the NPV is zero. As before, we suppose that expected revenues are realised, so that the project does not give rise to excess profits. The excess earnings that are assessed will then be as follows.

$$ExcessEarnings_1 = \$33.5m - \$25m - .10(\$100m) + \$5m = \$3.5m$$

$$ExcessEarnings_2 = \$32.13m - \$26.66m - .10(\$80m) + \$6.66m = \$4.13m$$

$$ExcessEarnings_3 = \$30.69m - \$30m - .10(\$60m) - \$5m = -\$10.31$$

$$ExcessEarnings_4 = \$29.18m - \$25m - .10(\$25m) + 0 = \$1.68m$$

These excess earnings now diverge from zero, and this is inconsistent with the underlying economic situation of no excess profits. The compounded excess earnings at the end of each year are as follows.

Yr (end)	Excess Earnings	Compounded Excess Earnings
1	$3.5*m*	$3.5*m*
2	$4.13*m*	$7.98*m*

3	-\$10.31*m*	-\$1.53*m*
4	\$1.68*m*	0

So, the compounded excess earnings over the full life of the project are zero, and this is consistent with the underlying economic situation of no excess profits. However, the fact that the compounded excess earnings are positive before the end of the project life gives rise to the difficulty that, in the event of a regulator assessing compounded excess earnings at the end of the first or second years in the project life, they may consider that control is warranted. Such a conclusion would be unwarranted.

Case 4: The asset value is expected to appreciate at the CPI inflation rate, but appreciates less rapidly than this. In particular, the asset value evolves as indicated in the second column below. Actual depreciation then follows in accordance with the straight line rule, and actual revaluations follow from this and the asset values.

Yr (end)	Asset Value	Depreciation	Revaluation
1	\$75*m*	\$100*m*(.25) = \$25*m*	0
2	\$40*m*	\$75*m*(.333) = \$25*m*	-\$10*m*
3	\$20*m*	\$40*m*(.50) = \$20*m*	0
4	0	\$20*m*(1) = \$20*m*	0

The expected revenues are as indicated in the first example above, and therefore the NPV is zero. As before, we suppose that expected revenues are realised, so that the project does not give rise to excess profits. The excess earnings that are assessed will then be as follows.

$$ExcessEarnings_1 = \$33.5m - \$25m - .10(\$100m) + 0 = -\$1.5m$$

$$ExcessEarnings_2 = \$32.13m - \$25m - .10(\$75m) - \$10m = -\$10.37m$$

$$ExcessEarnings_3 = \$30.69m - \$20m - .10(\$40m) + 0 = \$6.69m$$

$$ExcessEarnings_4 = \$29.18m - \$20m - .10(\$20m) + 0 = \$7.18m$$

These excess earnings diverge from zero, and this is inconsistent with the underlying economic situation of no excess profits. The compounded excess earnings at the end of each year are as follows.

Yr (end)	Excess Earnings	Compounded Excess Earnings
1	-\$1.5*m*	-\$1.5*m*
2	-\$10.37*m*	-\$12.02*m*
3	\$6.69*m*	-\$6.53*m*
4	\$7.18*m*	0

So, the compounded excess earnings over the full life of the project are zero, and this is consistent with the underlying economic situation of no excess profits. The fact that the compounded excess earnings are negative before the end of the project life gives rise to the possible difficulty that the firm could earn higher (i.e., monopolistic) revenues prior to the final year without control being prompted at that time. However, any such increase in revenues will eventually generate compounded excess earnings that are positive, and this is likely to discourage such activity.

10.2 Real and Quasi-Real WACC

We now consider the above examples in a situation in which a regulator uses a real or quasi-real WACC rather than a nominal WACC to assess excess earnings, and consequently omits actual asset revaluations from that assessment. Notwithstanding this, the firm still sets its prices in the fashion indicated earlier. In calculating excess earnings using a real or quasi-real WACC, the excess earnings are revenue less depreciation (some proportion of the asset value at the beginning of the year in accordance with SL depreciation) less the real or quasi-real cost of capital (the product of the real or quasi-real WACC and the asset value at the beginning of the year). However, the deductions for depreciation and the cost of capital reflect the asset value at the beginning of the year, and this nominal figure at the beginning of the year (as used in the previous section) must be converted to a nominal equivalent at the end of the year by inflating it at the appropriate inflation rate (the expected CPI rate in respect of a real WACC and the expected rate of appreciation in the relevant asset prices in respect of a quasi-real WACC). This adjustment ensures that excess earnings are zero for each year, under idealised conditions, i.e., the project NPV is zero, revenues match those expected, asset revaluations match those expected, and the expected rate of appreciation in the asset value matches the expected CPI rate.

Case 1: The asset value is expected to appreciate at the CPI rate (the real and quasi-real WACCs are then equal), and this appreciation rate is realised. Expected revenues are determined by the firm, and are as shown in the first example of the previous section. As before, expected revenues are realised, so that the project does not give rise to excess profits. The excess earnings are then assessed as follows, with the real cost of capital being [1.10/1.02] – 1 = .0784.

$$ExcessEarnings_1 = \$33.5m - \$25m(1.02) - .0784(\$100m)(1.02) = 0$$

$$ExcessEarnings_2 = \$32.13m - \$25.5m(1.02) - .0784(\$76.5m)(1.02) = 0$$

$$ExcessEarnings_3 = \$30.69m - \$26.01m(1.02) - .0784(\$52.02m)(1.02) = 0$$

$$ExcessEarnings_4 = \$29.18m - \$26.53m(1.02) - .0784(\$26.53m)(1.02) = 0$$

So, as with the use of a nominal WACC under the same scenario, the excess earnings are assessed to be zero in each year and this is consistent with the underlying economic situation of no excess profits.

Case 2: The asset price is now expected to appreciate at a rate other than the CPI rate (giving rise to a distinction between the real and quasi-real WACCs), and this appreciation rate is realised. In particular, the asset is expected to decline in value at 1% per year. The expected revenues, asset values and depreciation are as indicated in the second example of the previous section. As before, we suppose that expected revenues are realised, so that the project does not give rise to excess profits. Using a real WACC, the excess earnings that would be assessed are then as follows.

$$ExcessEarnings_1 = \$35.75m - \$25m(1.02) - .0784(\$100m)(1.02) = \$2.25m$$

$$ExcessEarnings_2 = \$32.67m - \$24.75m(1.02) - .0784(\$74.25m)(1.02) = \$1.49m$$

$$ExcessEarnings_3 = \$29.65m - \$24.50m(1.02) - .0784(\$49m)(1.02) = \$.73m$$

$$ExcessEarnings_4 = \$26.67m - \$24.25m(1.02) - .0784(\$24.25m)(1.02) = 0$$

These figures diverge from zero, and this is inconsistent with the underlying economic situation of no excess profits. The compounded excess earnings at the end of each year are then as follows.

Yr (end)	Excess Earnings	Compounded Excess Earnings
1	\$2.25*m*	\$2.25*m*
2	\$1.49*m*	\$3.96*m*
3	\$.73*m*	\$5.09*m*
4	0	\$5.60*m*

So, despite the underlying situation being one in which no excess profits arise, the compounded excess earnings that are assessed using a real WACC are positive at every point in the project's life. This may lead a regulator to conclude that control is warranted, and such a conclusion would be unjustified. This is a significant defect in the use of a real WACC.

The fundamental problem here is that the rate used to convert the nominal WACC to a real WACC is the CPI inflation rate, and this is inconsistent with the expected appreciation rate in the asset value. The use of a quasi-real WACC eliminates this problem, i.e., the quasi-real WACC is [1.10/.99] – 1 =.1111, and the excess earnings are then as follows.

$$ExcessEarnings_1 = \$35.75m - \$25m(0.99) - .1111(\$100m)(0.99) = 0$$

$$ExcessEarnings_2 = \$32.67m - \$24.75m(0.99) - .1111(\$74.25m)(0.99) = 0$$

$$ExcessEarnings_3 = \$29.65m - \$24.50m(0.99) - .1111(\$49m)(0.99) = 0$$

$$ExcessEarnings_4 = \$26.67m - \$24.25m(0.99) - .1111(\$24.25m)(0.99) = 0$$

So, the excess earnings are then zero for each year. However this approach does suffer from difficulties in estimating the expected rate of inflation in the relevant asset prices, to a much greater degree than in respect of CPI inflation.

Case 3: The asset value is expected to appreciate at the CPI inflation rate (the real and quasi-real WACCs are then equal), but appreciates more rapidly than this, as detailed in the third example in the previous section. Since the expected rate of appreciation in the asset price matches that same case, then the expected revenues are also as described there. These expected revenues are also realised, so that the project does not give rise to excess profits. The excess earnings assessed would then be as follows.

$$ExcessEarnings_1 = \$33.5m - \$25m(1.02) - .0784(\$100m)(1.02) = 0$$

$$ExcessEarnings_2 = \$32.13m - \$26.67m(1.02) - .0784(\$80m)(1.02) = -\$1.47m$$

$$ExcessEarnings_3 = \$30.69m - \$30m(1.02) - .0784(\$60m)(1.02) = -\$4.71m$$

$$ExcessEarnings_4 = \$29.18m - \$25m(1.02) - .0784(\$25m)(1.02) = \$1.68m$$

The compounded excess earnings at the end of each year are reported below.

Yr (end)	Excess Earnings	Compounded Excess Earnings
1	0	0
2	-\$1.47*m*	-\$1.47*m*
3	-\$4.71*m*	-\$6.33*m*
4	\$1.68*m*	-\$5.28*m*

So, despite the underlying situation being one in which there are no excess profits, compounded excess earnings are negative over the full life of the project and at most earlier points. This gives rise to the possibility of regulatory error, i.e., the firm earning higher (monopolistic) revenues without detection by the regulator. The problem here bears some resemblance to that arising with a nominal WACC in the fourth example in the previous section. However the situation is worse here because the compounded excess earnings here do not go to zero at the end of the project life. Consequently, the monopolistic revenues will never be detected here whilst they will eventually be detected when a nominal WACC is used.

Case 4: The asset value is expected to appreciate at the CPI inflation rate (the real and quasi-real WACCs are then equal), but appreciates less rapidly than this, as detailed in the fourth example of the previous section. Since the expected rate of appreciation in the asset price matches that same case, then the expected revenues are also as described there. These expected revenues are also realised, so that the project does not give rise to excess profits. The excess earnings that would be assessed are then as follows.

$$ExcessEarnings_1 = \$33.5m - \$25m(1.02) - .0784(\$100m)(1.02) = 0$$

$$ExcessEarnings_2 = \$32.13m - \$25m(1.02) - .0784(\$75m)(1.02) = \$0.63m$$

$$ExcessEarnings_3 = \$30.69m - \$20m(1.02) - .0784(\$40m)(1.02) = \$7.09m$$

$$ExcessEarnings_4 = \$29.18m - \$20m(1.02) - .0784(\$20m)(1.02) = \$7.18m$$

The compounded excess earnings at the end of each year are then reported below.

Yr (end)	Excess Earnings	Compounded Excess Earnings
1	0	0
2	\$0.63*m*	\$0.63*m*
3	\$7.09*m*	\$7.78*m*
4	\$7.18*m*	\$15.74*m*

So, despite the project merely covering its costs, compounded excess earnings are positive over the full life of the project and at most earlier points. This gives rise to the possibility of unwarranted regulatory interventions. This bears some similarity to the problem arising from the use of a nominal WACC in the third example of the previous section. However the situation is potentially worse here because the problem may accumulate over the life of the project whereas the problem must go to zero over the full life of the project when using a nominal WACC. This is a consequence of compounded excess earnings going to zero over the full life of a project when using a nominal WACC, but not when using a real or quasi-real WACC.

10.3 Summary

The previous two sections have considered assessments of excess earnings using nominal, real and quasi-real WACCs, under four scenarios. In all cases, the firm sets output prices so that it expects only to cover its costs, and the resulting expected revenues are realised. So, the project does not give rise to excess profits. The excess earnings that are assessed should then be zero. The first scenario involves the idealised conditions in which the asset value is expected to appreciate at the CPI rate, and does so. Excess earnings are zero in each year, whether assessed using a nominal, real or quasi-real WACC. In the second scenario, the asset value is expected to appreciate at a rate other than the CPI rate, and does so. In this case, excess earnings assessed using the nominal WACC are zero in each year. Excess earnings assessed using a quasi-real WACC are also zero in each year, but estimation of the appropriate quasi-real rate is problematic. By contrast, excess earnings assessed using a real WACC diverge from zero, and the compounded excess earnings diverge from zero even at the end of the project life. This gives rise to the possibility of regulatory errors. In the third and fourth scenarios, the asset value is expected to appreciate at the CPI rate, but appreciates at either a greater or lesser rate. In these cases, compounded excess earnings that are assessed will diverge from zero under each of the nominal, real and quasi-real approaches, and this gives rise to the possibility of regulatory errors. However, the errors are likely to be worse in the case of a real or quasi-real WACC because compounded excess earnings will not go to zero over the full life of the project.

So, in comparing the nominal and real approaches, the nominal approach is free of the possibility of regulatory errors in the second scenario but the real approach is not. In addition, in respect of the third and fourth scenarios, both approaches may give rise to regulatory errors but these are likely to be worse under the real method because compounded excess earnings do not go to zero over the full life of the project. Accordingly, the use of a nominal WACC is superior to the use of a real WACC in assessing excess earnings. If the real WACC were replaced by a quasi-real rate, the conceptual difficulty in the second scenario would be removed. However, difficulties will arise here for the regulator in estimating this quasi-real rate. Furthermore, the difficulties in the third and fourth scenarios still remain. So, the use of a quasi-real WACC is still inferior to the use of a nominal WACC. In light of all this, I favour the use of a nominal WACC.

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 in respect of the time value of money and risk. Nevertheless, allowed rates of return sometimes incorporate (or could be argued to warrant) allowances for additional factors, and these are considered here.

11.1 Asymmetric Risks

The first of these additional factors are called asymmetric risks, and they include the risk of assets being stranded, of assets being optimised out by a regulator, and of miscellaneous exposures to such events as natural disasters. 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 asymmetric risks, and in the context of investigating whether excess profits have arisen, the appropriate actions by the Commission are now considered. In respect of the miscellaneous risks such as natural disasters, the situation is as follows. The businesses deal with the matter as they choose, either by raising prices ex-ante or ex-post to protect themselves. If a business raises prices ex-post, the increased revenues will offset the increased costs and there is no resulting effect upon profits. No action is then required by the Commission. By contrast, if the business raises prices ex-ante, then during the period of the profit assessment, the business might experience a low incidence of these adverse events and consequently its profits will appear to be excessive. In the same way, an insurance company that did not experience any large claims during a period would appear to be charging excessive premiums. A possible response by the Commission to this problem would be to assess excess profits over a sufficiently long period that extreme events are represented to an extent that reflects their expected incidence. However, by virtue of being extreme, this will always be difficult to attain. Thus, if excessive profits appear to have been made, and the business deals with these events through ex-ante price adjustment, then the Commission would have to form a judgement as to whether the excessive profits can be explained by extreme events that are underrepresented. This requires some judgement about an appropriate ex-ante revenue increment to accommodate these costs (possibly expressed as a margin on WACC) and this would have to be deducted from the firm's actual revenues (or equivalently added as a margin to the WACC). In this event, the firm's costs would have to be reduced by an amount equal to any such costs that were incurred. If this adjustment can explain the observed excess profits, then there is no cause for concern. This contrasts with price control situations, in which firms lack the power to set their prices. In this case, some explicit allowance for these events must be provided by the regulator, and this could take the form of ex-post compensation, ex-ante compensation through the cash flows, or ex-ante compensation through the allowed rate of return.

In respect of optimisation risk, this would primarily arise if the businesses were assessed against an ODV or an ORC asset valuation basis, and the latter possibility has been raised (Commerce Commission, 2003, p. 10). In the event of assets being optimised out by the Commission, the resulting profit calculation will involve a smaller depreciation cost and a smaller base for determining the cost of capital. This will tend to produce an assessment of excess profits. 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 have to be granted, 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 by the Commission matches that reflected in the ex-ante protection, then the two effects offset; however, if the actual level of optimisations is higher or lower, then positive or negative excess profits will tend to be observed and this gives rise to a problem akin to that of the miscellaneous risks discussed above. In so far as the optimisation is induced by gold-plating, the latter may be indisputable in which case no ex-ante compensatory margin would be warranted. However, a regulatory judgement of gold-plating may simply represent a divergence of opinion amongst reasonable people, and this would then require some form of ex-ante compensation to be granted[42]. In respect of airfields, the Commission made no such allowance (Commerce Commission, 2002a)[43]. By contrast, in its draft decisions in respect of lines businesses (Commerce Commission, 2002b), the Commission proposed such a "margin on WACC" for those businesses that elected to be assessed against an ODV rather than a DHC asset valuation base. The airfields situation would seem to be more relevant to the gas pipeline situation, in the sense that both involve an ex-post assessment of excess profits by the Commission.

Finally, in respect of stranding, the businesses can be expected to have dealt with the possibility of a revenue fall by raising prices ex-ante[44]. However, the ex-ante allowance may have proved to be too small or too large in the particular period examined by the Commission, and this may give rise to the need for some judgement on the part of the Commission. In respect of whether the Commission removes stranded assets from the cost base, for the purpose of assessing excess profits, this is an aspect of optimisation and has been discussed above. In particular, if there is the possibility of the Commission removing assets from the cost base, then it must provide some form of ex-ante compensation, or else there will be a bias towards assessing excess profits. This compensation could take the form of a "margin on WACC" or an ex-ante allowance in the cash flows. In its draft decision in respect of lines businesses, the Commission proposed no allowance for stranding (Commerce Commission, 2002b), although the risk there may be less than in the case of gas pipelines. In any event the issue is unlikely to be substantial in the present context because stranding is most likely to occur for dedicated assets (supplying individual industrial consumers, which are at risk of closure). In these cases, gas pipeline businesses are likely to have entered into bilateral contracts to manage such risks. This paper does not attempt any assessment in this area.

[42] Failure to do so would imply that firms were subject to the possibility of costs being reduced, and therefore excess profits being assessed, without any counterbalancing possibility of costs being raised. This would induce a bias towards concluding that excess profits existed.

[43] It should be noted that the Commission applied the historic cost methodology to depreciable assets, and this limits the opportunities for optimisation.

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

In summary, in so far as the possibility of miscellaneous adverse risks such as natural disasters is dealt with by firms raising their output prices ex-ante, this gives rise to the problem that excess profit assessments may be inaccurate (too high unless such events have occurred). Corrections for this present considerable informational difficulties to regulators. In addition, the process of regulators optimising assets out for any reason other than indisputable cases of gold-plating requires some form of ex-ante compensation, and failure to provide this implies that excess profits will be overestimated. Even if an appropriate allowance is provided, this still leaves the problem that excess profits will be over or under estimated if the actual level of optimisations is more or less than provided for in the allowance. Finally, in respect of asset stranding, if the possibility of stranding leads to firms raising their output prices ex-ante, then the assessments of excess profits will be too high or too low if the extent of stranding is more or less than provided for. The problem of optimisation allowances still giving rise to errors in assessing excess profits involves both positive and negative errors, and could simply be ignored if the errors were thought to be slight. The remaining issues will generally give rise to overestimates of excess profits, which is disadvantageous to the firms. In so far as these biases were judged to be slight, the use of a domestic version of the CAPM and use of a WACC estimate from the high end of the range could be considered to be compensation for them.

11.2 Market Frictions: Costs of Financial Distress

LECG (2003a) 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. Yet 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" (ibid, p 20).

This could be expressed as saying that shareholders are exposed 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 (possibly framed as a margin on WACC), and deduct this from the firm's revenues (or equivalently add a margin to WACC). In this event, the firm's costs would have to be reduced by the level of any costs of this type that were actually incurred in the period examined. LECG do not mention this question of deducting incurred costs, but they do seem to indicate that such costs may have arisen for NGC in 2001 (LECG, 2003a, p 20).

Assuming that the gas pipeline businesses engage in ex-ante adjustment of their prices, I now consider the appropriate level of the gross margin on WACC. 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 (2003a) do not offer any evidence about the behaviour of the gas pipeline 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, it should be noted that this survey relates primarily to US firms, and therefore extrapolation to New Zealand firms warrants some caution[45]. 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.

Mindful that various possible explanations exist, LECG (2003a) 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 (2001b). 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-

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

specific, and therefore do not necessarily support the point under discussion[46]. 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 points, they might also be unwittingly overstating the need for a margin over WACC to address project-specific risks.

LECG (2003a) are mindful of the possibility that discount rates in excess of WACC could simply be an internal control device for countering overly optimistic cash flow forecasts, and they go to some trouble to rebut this suggestion. For example, they suggest that if such a practice exists then it will be known to the targets, and the sequence of resulting responses would be "…inconsistent with any sort of unsustainable equilibrium" (ibid, p 24). However we observe such behaviours in a wide variety of situations (such as the advertised prices for houses and cars) and yet it is clear that equilibria are attained in these cases. Furthermore, Mukherjee and Hingorani (1999, Exhibit 5) report that firms do increase their hurdle rates in response to this issue. Since LECG cites this research in support of their belief that project-specific risk matters, they can hardly ignore the same research when it supports conclusions that diverge from theirs.

In a subsequent submission, LECG (2003b) attempt to quantify the effect of market frictions. In doing so, they 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 (2003a). In fact, it is a type of market friction that appears to have little relevance to the gas pipeline industry. In a subsequent paper, LECG (2003c, p 13) appear to recognise this point and argue that it merely illustrates the potential effect of market

[46] 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.

frictions. My view is that a significant burden of proof lies with the industry, and this kind of illustration does not discharge it.

In a further submission relating to the lines businesses, but with implications for regulatory behaviour in general, LECG (2003c) 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 gas pipeline 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 in the gas pipeline industry.

Before summarising, it is also worth observing the behaviour of external advisors concerned with the valuation of firms rather than individual projects. Because these exercises are exposed to a high level of scrutiny, the composition of the discount rates used is generally highly transparent. My observation is that these discount rates do not incorporate allowances for project-specific risks of the kind under discussion. An example is PricewaterhouseCoopers, who are significant external valuation advisors in New Zealand and who have made a number of submissions to the Commission on WACC related matters on behalf of firms that may be subject to regulation. None of these submissions appear to contain any references to the issue of financial distress costs raised by LECG.

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, and they present a wide range of evidence on the question. However, a necessary condition for adding a margin to WACC is that the gas pipeline 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 incurred, and the only evidence offered on this matter by LECG indicates that such costs may have been recently incurred by NGC. Finally, in respect of the appropriate gross ex-ante increment to WACC, I consider that a significant burden of proof lies with the industry. LECG offer no evidence directly relating to the industry, 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 CAPM is advantageous to firms, and the recommendation to use a WACC estimate from the upper end of the suggested band is likely to be advantageous to them.

11.3 Timing Flexibility

LECG (2003a) 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 .067 (LECG, 2003b). The general principle here 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 based on the examples in LECG (2003a):

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, i.e., excess profits are zero. However, delay may be optimal. In particular, suppose that it is not optimal to invest until the expected future cash flow equals $2m per year. This is equivalent to saying that the firm should not invest until the expected rate of return on the $10m investment is 20% rather than 10%. If the firm invests at this point, the excess profits would be $1m per year.

LECG implies that the Commission should apply an allowed rate of return of 20% rather than 10%, for the purpose of assessing excess profits. However, the presence of timing flexibility in conjunction with a firm's ability to increase its value through this means is a form of excess profit, amounting to $1m per year in this example. Adding the proposed margin to WACC would simply undercut the whole process of identifying these excess profits. Accordingly the margin should not be invoked.

Consider the following analogy. Suppose that a firm has the opportunity to produce and sell a new product, the project cost is $10m, and the WACC is 10%. If the firm charges $100 per unit, then the expected future cash flow will be $1m per year, and therefore the present value of the future cash flows will be $10m, i.e., the NPV will be zero. Suppose also that the firm operates in an imperfectly competitive market and the optimal output price is $150. At this level, the expected future cash flows are $2m per year, i.e., the excess profits are $1m per year. This is equivalent to saying that the optimal action for the firm is to choose an output price that yields an expected rate of return on the $10m investment of 20% rather than 10%. Clearly, this would not be an argument for the Commission using 20% in assessing the firm's excess profits, and to do so would preclude the Commission from ever detecting the presence of these excess profits. Both this situation, and the situation involving timing flexibility, involve the firm altering its behaviour (choosing the optimal time to invest or the optimal price to charge) so as to earn an expected rate of return in excess of WACC. Neither situation warrants any margin being added to WACC for the purpose of assessing excess profits.

As an alternative to expressing the timing flexibility issue in terms of a margin on WACC, LECG (2003a) express the issue in terms of an additional cost, i.e., because timing flexibility is valuable, investors are willing to pay more for the firm's securities and "..this additional provision of capital represents an additional cost of investment in the new project" (ibid, p 21). However, referring to the monopoly-pricing example above, it is also true that monopoly power induces investors to pay more for the firm's securities. In both cases, the fact that investors are willing to pay more for the firm's securities is simply a reflection of the existence of excess profits. Treating this present value of excess profits as an additional cost, on which the firm should be permitted to earn its WACC, would simply undercut the whole process of seeking to identify excess profits.

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 present regulatory exercise in not one of price setting but one of examining past profits, and mere examination does not alter outcomes in this area. 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 the unregulated situation, but not the situation of price regulation, is due to the fact that the situations are quite different – revenues are 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. 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 simply reflects 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 $3m per year indefinitely. The present value of each project is $30m, with $20m being the present value of excess profits. 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 $20m, which is equivalent to a WACC increment of 20%. If the Commission were to add this 20% to WACC for the purpose of assessing excess profits, it would undercut the whole process of identifying the excess profits that are clearly present.

11.5 Information Asymmetries

LECG (2003d) 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 on existing projects. 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 20%. 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 20%, it would undercut the whole process of identifying the excess profits that are clearly 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 (on new projects). In effect, the act of adding a margin to WACC would disguise the excess profits earned by the new shareholders.

12. Conclusions

This paper has examined the estimation of the WACC of gas pipeline businesses, for the purposes of assessing excess profits in the industry. The primary conclusions are as follows. The model recommended is the nominal model recommended in the

Commission's inquiries into airfield operations and electricity lines businesses, and reflected in equations (1)….(5). In addition the parameter values recommended are a market risk premium of 7% along with bands of 6-8% (as with the Lines Businesses, and compared to 7-9% in the Airfields Report), use of the three year risk free rate, an asset beta for all of the gas pipeline businesses of .50 with bands of .40-.60, leverage of 40%, and a debt premium of 1.2%. The form of ownership of the gas pipeline businesses should not be a factor in estimating the WACC, except in so far as it affects the asset beta, and this appears impossible to quantify. Using these parameter values, and the current three year risk free rate of 5.0%, the lower limit on WACC, the point estimate, and the upper limit are 6.1%, 7.2% and 8.5% respectively. Given that there is some uncertainty as to the correct parameter estimates, and that the consequences of judging excess profits to exist when they do not are more severe than the contrary error, my view is that one should choose a WACC value from the higher end of the scale. The model used here for estimating the cost of equity capital is a domestic version of the CAPM, and this produces a cost of equity that is likely to be too high. This provides further protection against the possibility of using a WACC estimate that is too low. The WACC model used here is also nominal rather than real, and it is demonstrated that the former is superior in assessing excess earnings.

Asymmetric risks present particular difficulties. In so far as the possibility of asset stranding and miscellaneous adverse risks such as natural disasters is dealt with by firms raising their output prices ex-ante, this gives rise to the problem that excess profit assessments will be too high unless such events have occurred. Corrections for this present considerable informational difficulties to regulators. In addition, the process of regulators optimising assets out for any reason other than indisputable cases of gold-plating requires some form of ex-ante compensation, and failure to provide this implies that excess profits will be overestimated. Even if an appropriate allowance is provided, this still leaves the problem that excess profits will be over or under estimated if the actual level of optimisations is more or less than provided for in the allowance. The last of these issues involves both positive and negative errors, and could simply be ignored if the errors were thought to be slight. The remaining issues will generally give rise to overestimates of excess profits, which is disadvantageous to the firms. In so far as these biases were judged to be slight, the use of a domestic version of the CAPM and use of a WACC estimate from the high end of the range could be considered to be compensation for them.

In respect of the costs of financial distress, the situation in principle is similar to that of asset stranding and natural disasters. Even in the event that firms have raised their prices ex-ante in compensation, and a regulator was able to assess any costs of this type that were actually incurred, no convincing evidence is available that the appropriate ex-ante adjustment to output prices is substantial. Accordingly, I favour no increment 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 CAPM is advantageous to firms, and the recommendation to use a WACC estimate from the upper end of the suggested band is likely to be advantageous to them.

Finally, in respect of timing options, firm resource constraints, and information asymmetries, I do not consider in principle that any adjustment to WACC is warranted for the purpose of assessing excess profits.

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