THE EQUITY BETA FOR ETSA UTILITIES

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EXECUTIVE SUMMARY

The Essential Services Commission of South Australia (ESCOSA) has recently released its 2005-2010 Electricity Distribution Price Determination for the South Australian electricity distribution entity called ETSA Utilities (ESCOSA, 2005). Inter alia, this involves an equity beta of .80 at a leverage level of .60. In response, ETSA has applied for a review of this parameter estimate and argued for a value of at least one (ETSA, 2005). In support of this application, it has presented reports by Gray and Officer (2005) and also by NERA (2005).

This paper has examined the appropriate equity beta for ETSA, at a leverage level of .60. In view of the limited number of comparable Australian firms, US data is drawn upon, spanning fifteen years and involving nine sets of estimates with a median number of companies per set of 80. This yields an estimated asset beta of .30. In conjunction with the agreed gearing formula, and ETSA's leverage of .60, the resulting equity beta for ETSA is .75. This is broadly compatible with ESCOSA's estimate of .80, and considerably less than ETSA's estimate of at least 1.

This paper has also examined the analysis in Gray and Officer, which invokes data from four Australian firms, and subjects the data and beta estimates to a number of adjustments. Leaving aside the insufficient number of firms examined here, it is argued that some of these adjustments are inappropriate, and the result is to alter Gray and Officer's estimate from at least 1 to less than .82. Again, this is comparable with ESCOSA's estimate of .80.

The paper has also examined the analysis in NERA, to the extent that it deals with issues other than the judgements of other regulators. Five of their arguments are considered here. Of these, one is more comprehensively addressed by Gray and Officer, two are argued to be invalid, one to be irrelevant, and the remaining point to have been applied at the wrong level.

1. Introduction

The Essential Services Commission of South Australia (ESCOSA) has recently released its 2005-2010 Electricity Distribution Price Determination for the South Australian electricity distribution entity called ETSA Utilities (ESCOSA, 2005). Inter alia, this involves an equity beta of .80 at a leverage level of .60. In response, ETSA has applied for a review of this parameter estimate and argued for a value of at least one (ETSA, 2005). In support of this application, it has presented reports by Gray and Officer (2005) and also by NERA (2005). This report offers an estimate on this parameter, and then goes on to analyse the reports by Gray and Officer and by NERA.

2. The Estimate

2.1 Introduction

In estimating the equity beta of ETSA, it is generally accepted by the parties that the gearing formula is as follows

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

where β_e is the equity beta, β_a is the asset beta and L is the leverage. It is further agreed that the leverage for ETSA is .60. This paper does not contest either equation (1) or the leverage of .60. So, the only remaining issue is the appropriate asset beta for ETSA. The usual and appropriate practice here is to obtain estimates from broadly comparable companies, suitably adjusted for sources of difference between them and the entity of interest. An essential preliminary is to identify the factors underlying asset betas, as this guides the choice of comparators. This is done in the next section, after which an estimate is offered.

2.2 Underlying Factors

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

$$\beta_j = \frac{Cov(R_j, R_m)}{Var(R_m)} \qquad (2)$$

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

$$R_j = a_j + b_{1j}F_1 + b_{2j}F_2 + ...+ b_{kj}F_k + e_j \qquad (3)$$

where b_{1j}, b_{2j}……b_{jk} are the sensitivities of R_j to these common shocks. If these macro-economic shocks are defined to be independent of one another, then substitution of (3) into (2) reveals the following (Dybvig and Ross, 1985)

$$\beta_j = b_{1j}\left[\frac{Cov(F_1, R_m)}{Var(R_m)}\right] + ... + b_{kj}\left[\frac{Cov(F_k, R_m)}{Var(R_m)}\right] \qquad (4)$$

So the beta of asset j is a linear function of its sensitivity coefficients b_{1j}….b_{kj}. Since the terms [ ] in equation (4) are identical across assets, then differences in asset betas must arise from differences in the sensitivity coefficients on the common shocks. Chen, Roll and Ross (1986) suggest that these common shocks are unexpected changes in real GNP, inflation, market risk aversion and the long-term real interest rate. Amongst equities, the chief source of variation in betas should be in the sensitivities of asset returns to real GNP. The sensitivity to inflation and the long-term real interest rate should be similar[1], whilst the sensitivity to market risk aversion should largely reproduce that for real GNP[2].

The sensitivity of unlevered returns to real GNP shocks will be driven by a number of underlying factors. The first factor is industry, i.e. the nature of the product or service. Firms producing products with low income elasticity of demand (necessities)

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

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

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[3]. 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, although this has no implications for electricity distributors[4]. A third aspect of customer composition is the personal/business mix, with the latter being more sensitive to GNP shocks in the case of electricity distributors[5].

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 generally embodied in the revenues of electricity distributors.

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

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

[4] The demand for a product by foreign customers would have less sensitivity to Australian 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 Australia. Electricity distributors are characterised by demand arising from local customers.

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

restrictions on prices, and in the face of a positive economy-wide demand shock, a profit maximising monopolist will increase its output price. However an output price that is contractually fixed for some period prevents the firm from immediately acting in that way, and thereby reduces the firm's beta. By contrast, in the presence of an 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[6].

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 US industries of this type have amongst the lowest betas after allowing for various firm specific variables. However, as the reset interval increases, the adjustment of the output price so as to preserve the firm's rate of return is increasingly delayed; exposure to macro-economic cost shocks then increases, and this should raise the firm's beta. Consistent with this, Alexander et al. (1996) show that utilities subject to UK style regulation (in which prices are set for five years) have significantly larger average asset betas than for utilities subject to US regulation (in which prices are set for only one year). Lally (2002) 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 intuition 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.

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

The sixth factor is the degree of monopoly power, i.e., the price elasticity of demand for the firm's output. 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 electricity distributors, their monopoly power may be diluted by the countervailing power of their large customers. So, if monopoly power affects beta, then the effect of any such countervailing power would be to mitigate that beta effect[7].

The seventh factor is the extent of the firm's real options, most particularly the option to adopt new products ("growth" options). Myers and Turnbull (1977, pp. 331-2) note that the betas of firms will diverge from those of their individual projects if the firms have growth options. The existence of such growth options should increase the firm's sensitivity to real GNP shocks, as the values of these growth options should be more sensitive to real GNP shocks than 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, electricity distributors 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., they enjoy monopoly power), then firms with greater operating leverage (higher fixed operating costs to

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

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 modelled this. However the assumptions noted above, which underlie this work, are very restrictive. Booth (1991), by contrast, examines a perfectly competitive firm facing price uncertainty, and reaches the opposite conclusion about the sign of the relationship between operating leverage and beta. In respect of empirical work, Lev (1974) shows that operating leverage is positively correlated with equity beta, for each of three industries. Mandelker and Rhee (1974) refine the procedure and reach the same conclusion in respect of a set of firms spanning numerous industries. However Lev's conclusions are specific to the three industries examined. Furthermore Mandelker and Rhee's conclusions are at best valid for the majority of firms included in the data set, i.e. some industries may exhibit the opposite pattern but are outweighed in the data set. These concerns about lack of generality of the results are prompted and supported by the theoretical literature just surveyed. Nevertheless, the situation facing electricity distributors (which are invariably local monopolists) would seem to correspond more to that modelled by Rubinstein et. al. than Booth, and this implies that their high operating leverage should magnify their asset betas.

The last factor is market weight. Increasing an industry's weight in the market proxy against which its beta is defined will draw its beta towards 1, although not necessarily in a monotonic fashion (Lally and Swidler, 2003). Even for a market weight as low as 5%, the effect can be substantial. Electricity distributors and possible comparators generally have limited weights in market indexes[8]. Consequently this point is not significant.

2.3 Estimates

With this background, I now turn to the question of estimates. The best comparators for ETSA will be Australian electricity distribution businesses subject to the same

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[8] In respect of Australia, there are currently five listed companies of this type included in the AOI (the generally employed index of the Australian market), comprising Alinta, AGL, Australian Pipeline Trust, Envestra and Gasnet. Their aggregate market capitalisation is about $11b (price data from the ASX and number of shares from the companies' most recent Annual Reports). This represents less than 2% of the capitalisation of the AOI.

regulatory regime. Such firms could be augmented by gas distribution firms, on the grounds that the factors underlying the asset betas are similar and therefore the asset betas should be similar. However, as revealed in ESCOSA (2005), there are only six Australian companies of this type. In my view, this is far too small a set to place any great reliance upon. Consequently, it is necessary to consider foreign firms. These firms should be electricity distributors, with possible augmentation by firms in similar industries such as gas distribution. In addition, they should be subject to a regulatory regime that gives rise to similar systematic risk to ETSA.

The regulatory regime facing ETSA involves setting of output prices every five years, but subject to two types of revisions within a five year cycle. Firstly, if sales for a particular year vary from that forecast in setting the allowed output prices, 85% of the revenue variation is stripped out, i.e., if sales are larger (smaller) than expected, subsequent revenues are reduced (increased) by 85% of the volume shock (ESCOSA, 2005, section 12.8.1)[9]. Thus 15% of the revenue shock is retained or recovered. This is called the "Q factor". ETSA claims that revenue changes induce a cost change equal to 13% of the revenue change (ibid, p 172). Thus the proportion of revenues retained or recovered closely matches the associated cost shock. The effect of all this is to essentially eliminate ETSA's exposure to volume shocks, and therefore to systematic risks manifested in the form of volume shocks. Secondly, if ETSA experiences a cost shock that is outside of its control, then its output prices will be adjusted to compensate, i.e., the cost shock is passed through to consumers. Systematic cost shocks (in addition to those arising purely from volume shocks) will be of this type, i.e., they will satisfy this test for passing through to consumers. So, ETSA is protected from systematic risks manifested in the form of cost shocks.

In conclusion then, the effect of ETSA's regulatory regime is to largely shield it from systematic risks manifested in the form of cost or volume shocks. Accordingly, its systematic risk should be very low. The natural (foreign) comparators for it are then US firms involved in electricity transmission and generation. In the interests of expanding the set of comparators, these could be augmented with US firms involved

[9] The actual correction is slightly smaller because the first .5% of the sales forecast error is ignored.

in gas distribution[10]. Both sets of US firms are subject to annual price resetting, which induces very low exposure to systematic risks. This annual price resetting contrasts with the five yearly price cycle for ETSA. However, the effect of revising ETSA's prices within the cycle in the face of uncontrollable cost and volume shocks would be to produce a similarly very low exposure to systematic risks.

Estimates of the asset betas of these US firms are now examined, and are drawn from Lally (2004a). Damodaran (2004) presents estimated equity betas for 64 US electric utilities (SIC codes 4911-4913) and 29 gas distribution firms (SIC code 4920)[11]. The book value of debt and the market value of equity are also presented. Using this data, estimated asset betas are generated for each of the firms, using the Hamada (1972) formula with a company tax rate of .34, i.e.,[12]

$$\beta_a = \frac{\beta_e}{1 + \left[\frac{L}{1-L}\right](1-T_c)} \quad (5)$$

The result is an average of .35 for the electric utilities and .17 for the gas distribution firms, with an overall average of .29. However these average asset betas reflect market leverage and the tax environment in the US rather than for Australia. The adjustment formula is detailed in Lally (2002), and requires knowledge of market leverages and tax parameters in the two markets. Furthermore, Lally (1998a) shows that the relevant market leverage for the foreign market is the average over the beta estimation period, along with the current value for Australia. The Australian equivalent to the US asset beta is then as follows

[10] A further set of comparable firms are US water utilities. However the number of such firms is small, and they are accordingly ignored.

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

[12] The Hamada formula differs from equation (1) in including a corporate tax term. Such a difference in the formulas is appropriate, in light of the differences in tax regimes in the US and Australia (most particularly the absence of dividend imputation in the US and its presence in Australia).

$$\beta_a = \beta_{aF} \frac{\left[1 + \frac{L_F}{(1-L_F)}(1-T_c)\right]}{\left[1 + \frac{L}{(1-L)}\right]} \tag{6}$$

where β_{aF} is the US beta estimate, L_F is the US market leverage averaged over the beta estimation period, T_c is the US company tax rate and L is current Australian market leverage[13]. Recent estimates for the leverages of the two markets are .26 for the US and .19 for Australia (Ernst and Young, 2000). In addition, the US company tax rate is 0.34. Following equation (6), the US asset betas of .35, .17 and .29 for electric utilities, gas distribution firms and the overall average are unchanged by this adjustment formula, i.e., the taxation and market leverage differences coincidentally net out.

Estimates of this type are subject to estimation error and vary with the length of the historical period. Consequently one should consider the results from a variety of periods. In respect of Damodaran, the fact that his 2004 beta estimates are based on returns data over the last five years implies that 1998 estimates would be additional independent information. Damodaran (1998) presents industry average asset betas for that year, of 0.46 for both electric utilities (93 firms) and natural gas distribution firms (54 firms). However these averages involve degearing at the industry rather than the individual firm year, which is inappropriate. They are also clearly based on the Value Line "adjusted" betas rather than the raw regression betas, and this adjustment formula is of the Blume (1971, 1975) type. Lally (1998b) shows that the Blume formula is biased. Thus, one needs to draw upon unadjusted betas for the individual firms. Unfortunately, this data is not displayed on Damodaran's website and attempts to obtain this 1998 data from both Damodaran and Value Line were unsuccessful. However, I am in possession of Damodaran's unadjusted individual company data for 2003. Conversion of the estimated equity betas to asset betas as before produces an average of .26 for the electric utilities and .17 for the gas distribution firms and an overall average of .23. By contrast, Damodaran's industry averages are .46 and .40.

[13] The presence in the formula of a company tax rate for the US but not Australia reflects the difference in tax regimes in the two markets. The effect of this point is limited because it is largely offset in equations (5) and (1).

The discrepancy (of about .20) is primarily attributable to the use of the Blume betas[14]. Thus, Damodaran's 1998 industry average asset beta of .46 for both electric utilities and gas distribution would imply a value of about .26 if calculated in the way desired here, and this latter figure will be invoked. The adjustment in equation (6) requires the average US market leverage over the beta estimation period 1994-1998. Fama and French (1999, Figure 1) give US market leverages for each of the years 1994-1997, and the average is 0.27. Again, following equation (6), the adjustment for differences in market leverage and the taxation regime between the US and Australia has no net effect. So, the estimated asset beta for both US electric utilities and gas distribution firms remains 0.26.

A second source of estimates is Bloomberg, although only recent (2004) estimates of the equity betas are available. The equity betas are estimated using the most recent two years of returns data, and are therefore more "recent" than the Damodaran estimates, although facing greater exposure to estimation error on account of the shorter period used[15]. Conversion of the equity to asset betas as above produces an average of .27 for the US electric utilities (68 companies), .20 for the gas distribution firms (25 companies) and an overall average of .25 (93 companies). Again, following equation (6), the adjustment for differences in market leverage and the taxation regime between the US and Australia has no net effect.

A third source of estimates is Alexander et al (1996, Appendix A2), using returns data from the period 1990-94. In this case, only asset betas are disclosed, with the de-gearing having been performed by the authors. The result is .30 for the electric utilities (9 companies), .20 for the gas distribution companies (12 companies) and .25 for firms with dual operations (14 companies). The overall average is .25. The adjustment in equation (6) requires the average US market leverage over the beta estimation period 1990-1994. Fama and French (1999, Figure 1) give US market leverages for each year in this period, and the average is 0.34. So, following equation

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

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

(6), the resulting figures are .33 for the electric utilities, .22 for the gas distribution companies, .27 for dual-operation firms and .27 overall.

A fourth source of evidence is estimates provided by Ibbotson Associates (1998, 2004). Again, the equity beta estimates are based on the previous five years of returns data and are available for several earlier years. Recent estimates (using 1999-2003 data) and those for 1998 (using 1993-1997 data) are used. Ibbotson reports only the industry median asset beta rather than the individual company figures, and the individual company estimates are based on the Vasicek (1973) adjustment process. Lally (1998b) identifies a number of difficulties in this process, although the effect on an industry median should be modest. For 2004, the figures given are .12 for electric utilities (41 firms) and .06 for gas distribution companies (9 firms), implying an overall average of .11. For 1998, the figures are .32 for electric utilities (66 firms) and .33 for gas distribution companies (42 firms), implying an overall average of .32. Again, following equation (6), the adjustment for differences in market leverage and the taxation regime between the US and Australia has no net effect.

A final source of estimates are those obtained from Standard and Poors. Their equity betas are estimated using five years of data, and estimates for 1989-1993, 1994-1998 and 1999-2003 were obtained. In respect of the electric utilities, conversion of the equity beta estimates to asset betas as before yields average asset beta estimates of .31 for 1989-1993 (36 firms), .19 for 1994-1998 (37 firms) and .18 for 1999-2003 (42 firms). For the gas distribution firms, the figures are .26 for 1989-1993 (29 firms), .32 for 1994-1998 (36 firms) and .19 for 1999-2003 (38 firms). Following equation (6), the adjusted results are .34, .19 and .18 for the electric utilities, whilst those for the gas distribution firms are .29, .32 and .19. The averages across the two sets of firms are .32 for 1989-1993, .26 for 1994-1998 and .19 for 1999-2003.

Table 1 below summarises these nine sets of estimates (the number of firms appears in brackets). The median for gas distribution firms (.22) is below that of electric utilities (.27). However, the overall discrepancy is less than one standard deviation of the estimate, and therefore is not statistically significant. In view of this, and the fact that my prior belief was for equal asset betas across the two industries, I propose to treat the data for the two industries as being drawn from the same underlying population. This leads to focusing upon the median of the overall results, which is .26. Across the nine sets of results, the median number of companies per set is 80.

Table 1: Asset Beta Estimates for US Firms

Source	Data Period	EUs	Gas	Overall
Value Line	1999-2003	.35	.17	.29 (83)
Value Line	1994-1998	.26	.26	.26 (147)
Bloomberg	2002-2003	.27	.20	.25 (93)
Alexander	1990-1994	.33	.22	.27 (35)
Ibbotson	1999-2003	.12	.06	.11 (50)
Ibbotson	1993-1997	.32	.33	.32 (108)
S & P	1999-2003	.18	.19	.19 (80)
S & P	1994-1998	.19	.32	.26 (73)
S & P	1989-1993	.34	.29	.32 (65)
Median		.27	.22	.26

The outliers in the set of results are the most recent Ibbotson estimates. A possible explanation is offered by Annema and Goedhart (2003), who show that industry equity betas for the TMT sector (telecommunications, media and technology) were unusually high in the period 1998-2001, while those for other industries were unusually low. The reason here may be chance or a reflection of the (temporary) surge in the market weight of the TMT sector in the period 1998-2001[16]. If this is the explanation, then it has not affected the Standard and Poors results to this degree, and does not seem to have affected the Value Line results at all[17]. The outcome from

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

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

simply ignoring all estimates that draw upon data from the period 1998-2001 inclusive is to raise the median of the overall results only slightly, from .26 to .30. Taking account of all this, I favour an estimate of .30 for the asset beta of US electric utilities and gas distribution firms.

This estimate of .30 is then inserted into equation (1), along with a leverage ratio for ETSA of .60. The result is an estimated equity beta for ETSA as follows.

$$\beta_e = .30\left[1 + \frac{.60}{1-.60}\right] = .75$$

This estimate of .75 is broadly consistent with ESCOSA's estimate of .80, but draws upon different data. In particular, it is based entirely upon estimates for US electricity and gas firms whereas ESCOSA's estimate is largely based upon estimates for Australian firms. Gray and Officer (2005, p 29) rightly observe that estimates from foreign firms are complicated by the fact of being computed against a market index whose composition may differ from that of Australia, and Lally's (2004b) analysis of this issue supports those concerns. However, the available Australian data is far too limited to be relied upon.

3. Analysis of Gray and Officer

3.1 Introduction

Gray and Officer (2005) estimate the equity beta for ETSA by considering only four Australian companies, and undertake a number of transformations designed to improve the statistical reliability of the estimates. They conclude with an estimate of at least 1. The chief difficulties with this approach are the recourse to a very limited number of Australian firms, and to a limited period of only five years. By contrast, the US data sources considered draw upon much larger sets of firms, with a median number of firms equal to 80 (see Table 1). In addition, the US data spans a period of 15 years. Notwithstanding these points, there are a number of aspects of the transformations in Gray and Officer that are worthy of comment, and these are as follows.

3.2 The Blume Transformation

Gray and Officer invoke the Blume (1971, 1975) transformation formula, which has the effect of shifting estimates that differ from one towards one. However Lally (1998b) identifies a number of problems with the Blume process, as follows. First, the process captures and extrapolates any tendency for the true betas of firms to shift towards or away from one over time. However any such shift would be peculiar to the country and period examined by Blume (being the US in the period 1926-1968), and would therefore have no necessary relevance to ETSA or Australian firms in general at the present time. Blume (1975) demonstrates that the true betas of US firms have on average shifted towards one over the period examined by him, and attributes this to the possibility that new projects adopted by firms have less extreme betas than the firms' existing projects (this process includes diversification arising from mergers and takeovers). This point is also made by the Victorian ESC. Gray and Officer explicitly reject the suggestion that the true betas of firms do shift over time in this fashion, and attribute the Blume process entirely to estimation error in betas ("order bias"). However their claim simply contradicts the evidence presented by Blume (1975) on this very matter; Gray and Officer neither refute that evidence nor even refer to it.

The second problem with the Blume process is that, even if the shift of true firm betas towards one that was characteristic of US firms in the period examined by Blume is also characteristic of Australian firms in general at the present time, it will not have any application to the circumstances of an *individual* project. Of course, ETSA is an individual project whose beta cannot be altered merely through the diversification behaviour of any firms within which it is embedded.

Finally, even if the Blume process were a manifestation of only estimation error, the formula has the effect of shifting beta estimates that are above or below one towards one rather than the industry average for the firm in question. Thus, if a beta estimate was .60, the Blume formula would raise it even if the industry from which that firm was drawn was characterised by low beta estimates (averaging .50 over a large number of firms) and there was a clear financial rationale for such low estimates. If raw estimates are to be transformed in some such way, the more appropriate point to which they should be shifted is the industry average, because this takes account of additional relevant information. This practice is generally adopted in applications of Vasicek's (1973) method. To draw an analogy, suppose that the heights of people are measured with error, and one has just measured the height of an adult male at 1.6m. Given an average height for adult males of 1.75m, the Blume transformation would substantially raise the estimated height of this individual, even if one knew that he was a jockey and that the average estimated height of male adult jockeys was 1.5m. By contrast, the Vasicek method would (sensibly) lower the estimated height of this individual, towards the estimated average height of male adult jockeys.

3.3 Outliers

Gray and Officer remove a number of outliers, and state that their objective is to "eliminate a small number of observations that are so extreme and influential as to bias the beta estimate" (ibid, p 35). However they proceed to remove outliers that are more than 1, 1.5 and 2 standard deviations from the regression line. They do not state what percentage of observations are removed by this process. However, if the deviations were distributed in accordance with the "normal" distribution, the percentages of observations removed would be 32%, 13% and 5% respectively. It is hard to reconcile the removal of 32% or even 13% of observations with the intention of removing a small number of extreme observations. At best, that description could be applied to observations more than two standard deviations from the regression line. Thus, in their Tables 5 and 6, the appropriate column of beta estimates to examine is the first, and the estimated betas here are around 1.

3.4 Removal of Data Relating to the Technology Bubble

Gray and Officer remove all data from the period July 1998 to June 2001, on the grounds that this period was characterised by a freak technology stock bubble which induced a reduction in the betas of utilities. This argument is supported by the evidence in Annema and Goedhart (2003). However, the deletion of data that forms part of the probability distribution (even if it is over represented in the sample data) must lead to a beta estimate that is now too high rather than too low. By analogy, consider an insurance company that deletes data from periods in which claims were particularly high, and then proceeds to estimate the appropriate insurance premium. If the period of high claims is represented in the data to an extent beyond that of its probability, then failure to delete it will yield an estimate of the appropriate insurance premium that is too high, consistent with the reasoning of Gray and Officer. However, the deletion of this high claims data must lead to an estimate of the premium that is too low. The correct value lies between the results from not deleting and deleting the unusual data. So, Gray and Officer's beta estimates in Table 5 and 6 are biased upwards. The degree of the resulting bias is unknown.

My own analysis in section 2.3 examines this issue, but finds that deletion of the technology bubble period raises the estimated asset beta only moderately, from .26 to .30. I invoke the latter figure, but this could be justified on the grounds of rounding alone.

3.5 Implications

I now consider the implications of these points for the beta estimates of Gray and Officer. In respect of the deletion of data relating to the technology bubble, this simply implies that any estimates from Gray and Officer are biased upwards. In respect of outlier deletions, the appropriate estimates from Gray and Officer are those involving deletion of outliers beyond two standard deviations. Finally, in respect of the Blume transformation, this should not be undertaken. Thus, Gray and Officer's estimates of betas involving deletion of outliers beyond two standard deviations are re-estimated without recourse to the Blume transformation.

This analysis will be conducted upon the portfolio beta estimate in Table 6 involving mean returns, and the full five years of data. This reflects the superiority of the Table 6 results (as explained by Gray and Officer), the fact that mean (but not median) returns are consistent with portfolio formation, and the statistical advantages of using the longest available period. The estimate of the equity beta for ETSA by Gray and Officer in this case is 1.01 (Gray and Officer, 2005, Table 6). This estimate of 1.01 must now be stripped of the Blume transformation.

Let the raw beta estimate for the portfolio be denoted β_R. Gray and Officer transform this estimate using Blume's formula. They do not disclose the formula used but they do refer to its use by Bloomberg and Value Line, and the latter use the following formula (from Blume, 1971).

$$\beta_B = .34 + .68\beta_R$$

This Blume estimate β_B is then degeared, using the aggregate leverage of the four companies (AGL, Alinta, APT and Envestra) examined by Gray and Officer. In respect of estimates from monthly sampling, as used by Gray and Officer, their leverages are .35, .33, .45 and .67 respectively (ESCOSA, 2004, Table 10.2). The aggregate leverage is then .47. So, with leverage of .60 for ETSA, the gearing adjustment used by Gray and Officer, must have been as follows.

$$\beta_e = \frac{[.34 + .68\beta_R]}{\left[1 + \dfrac{.47}{1 - .47}\right]}\left[1 + \frac{.60}{1 - .60}\right] \tag{7}$$

Gray and Officer’s result here is 1.01 (Gray and Officer, 2005, Table 6). Insertion of this into equation (7) then implies a raw beta estimate for the portfolio of $\beta_R = .621$. Thus, Gray and Officer’s calculation must have been as follows.

$$\beta_e = \frac{[.34 + .68(.621)]}{\left[1 + \dfrac{.47}{1 - .47}\right]}\left[1 + \frac{.60}{1 - .60}\right] = 1.01$$

Without the use of the Blume transformation, the gearing adjustment to this beta estimate would then yield an equity beta for ETSA as follows.

$$\beta_e = \frac{.621}{\left[1 + \dfrac{.47}{1 - .47}\right]}\left[1 + \frac{.60}{1 - .60}\right] = .82$$

Thus, removal of the Blume transformation reduces the estimated equity beta from 1.01 to .82. Furthermore, on account of Gray and Officer deleting data relating to the technology bubble, this estimate of .82 is biased up. Notwithstanding the statistical limitations in this Australian data, the result is remarkably consistent with the estimate of .75 presented in section 2, and derived from US rather than Australian data.

Furthermore, the two estimates are collectively consistent with the ESCOSA's estimate of .80.

4. Analysis of NERA

NERA raises a number of arguments concerning the equity beta of ETSA. Most of these points relate to the judgements of other regulators, and I do not consider these to be a source of evidence per se. Nevertheless they do raise five arguments that are not simply the judgements of other regulators, and these are examined as follows.

NERA's first argument relates to ESCOSA's (2005) Figure 10.2. In particular, they argue that ESCOSA's most recent estimates of the equity beta for ETSA are afflicted by the technology bubble, and therefore should be disregarded in favour of the earlier estimates (NERA, 2005, paras 47-50). However, in so far as the technology bubble data is considered to be inadmissible, the better reaction is to remove the offending data and then re-estimate the betas using the remaining data. This has been done by Gray and Officer, and their results have been analysed in the previous section. So, this work supplants NERA's line of argument.

NERA's second argument is that, over the period since their privatisations, the average return on the Australian gas and electricity distributors examined by ESCOSA has averaged 23.3% compared to the average market return over the equivalent period of 10.9%. From this they conclude that the betas of the firms must be high (ibid, paras 51-54). However, a beta for a company is the sensitivity coefficient of its returns relative to market returns, and its estimation therefore requires at least *two* observations on each return variable; NERA has presented only *one* observation on each return variable. In the face of only one observation on each variable, there are alternative explanations for this outcome. One is that the betas of these companies are low and they earned larger profits during this period than expected, leading to the high average returns relative to the market. NERA describes this one data point as a "reality check". It is an interesting concept of reality that can so readily attribute to a high beta what may simply be due to unexpectedly large profits.

NERA's third argument concerns the extraction of implied beta estimates from US regulatory judgements, in which the Dividend Growth Model (DGM) is used to generate the estimated cost of equity. In response to ESCOSA's argument that these implied beta estimates are inconsistent with the requirement to use the CAPM for estimating ETSA's cost of equity capital, NERA argues that there is no conceptual inconsistency between the DGM and the CAPM (ibid, paras 67-72). Their statement is true, but irrelevant. What one requires here is the beta estimates of the US regulators. Had this question been put to them, their estimates might have been quite different to those deduced by NERA.

To illustrate the potential for differing estimates of the equity beta from these two approaches, suppose that the risk free rate is .05 and that regulators employing the CAPM estimate the market risk premium at .06 and the equity beta for a certain type of firm at .80. This leads to an estimated cost of equity of

$$\beta_e = .05 + .06(.80) = .098 \qquad (8)$$

Suppose also that regulators employing the DGM also estimate the cost of equity for these types of firms at .098. If we agree that the market risk premium is .06, then the equity beta implied from the second group of regulators would be .80, matching that from the first group of regulators. Now, suppose that the risk free rate falls to .04 whilst the estimated beta and the market risk premium are unchanged. For those regulators using the CAPM, and following equation (8), the estimated cost of equity will fall to .088. By contrast, for those regulators using the DGM, there might be no immediate change in the estimated cost of equity because the risk free rate does not explicitly appear in the DGM. With no change in the estimated cost of equity (of .098) and an observable fall in the risk free rate to .04, the implied beta would then have to satisfy the following equation.

$$.04 + .06\beta_e = .098$$

The solution is an implied beta estimate of .97, contrasting with the earlier implied estimate of .80. Thus, the implied beta estimate obtained from regulators who employ the DGM now diverges from the beta estimate explicitly used by regulators who employ the CAPM. The divergence is not attributable to a difference in the regulators' views about beta but to a defect in the implementation of the DGM.

NERA's fourth argument is that regulators should err on the side of caution in estimating equity betas (i.e., err on the high side) due to the asymmetric consequences of estimation error (ibid, section 3.8). I agree that regulators should err on the high side but this adjustment should be made at the level of WACC rather than at the level of each individual parameter. By doing so at the WACC level, the regulator can choose WACC so as to control the probability (at some specified level such as 10%) of choosing a WACC value that is too low. By contrast, if that control level were applied to each individual parameter, the resulting control level at the WACC level is liable to be considerably less.

NERA's final argument is that the presence of revenue adjustments (that have the effect of protecting ETSA against volume shocks) do not lower the systematic risk of ETSA (ibid, section 3.10), i.e., the "Q factor" does not lower the systematic risk of ETSA. In support of this argument, they raise four points. Firstly, they argue that there is no theoretical support for a link between electricity sales and returns on the market portfolio. This is incorrect. Market returns are positively correlated with firms' profits, which are positively correlated with firms' sales. In turn these are positively correlated with firms' demand for all intermediate goods, including electricity. Furthermore, firms' sales are positively correlated with aggregate domestic spending by households, which includes expenditures on electricity. Secondly, they argue that there is no empirical support for a link between electricity sales and returns on the market portfolio, i.e., the relationship is statistically insignificant. The same observation could be made about the beta estimates of most Australian electricity and gas distributors (see Gray and Officer, 2005, Table 1). The explanation for this in both cases is more likely to lie in the extent of noise in the data (which precludes attainment of statistically significant results) rather than the lack of an underlying positive relationship. The remaining two arguments from NERA on this matter involve comparisons between ETSA and its peers in the electricity sector, and lead them to the view that ETSA has more volatility in its sales. By implication, ETSA's cost of capital should be higher than its peers. Whether this conclusion is true or not does not bear on the question of whether ETSA's revenue adjustments lower its systematic risk. So, these comparisons between ETSA and its peers are irrelevant.

In summary, NERA's first point has been dealt with more comprehensively by Gray and Officer, their second point is invalid, their third point is irrelevant, their fourth point is applied at the wrong level, and their fifth point is also invalid.

5. Conclusion

This paper has examined the appropriate equity beta for ETSA, at a leverage level of .60. In view of the limited number of comparable Australian firms, US data is drawn upon, spanning fifteen years and involving nine sets of estimates with a median number of companies per set of 80. This yields an estimated asset beta of .30. In conjunction with the agreed gearing formula, and ETSA's leverage of .60, the resulting equity beta for ETSA is .75. This is broadly compatible with ESCOSA's estimate of .80, and considerably less than ETSA's estimate of at least 1.

This paper has also examined the analysis in Gray and Officer, which invokes data from four Australian firms, and subjects the data and beta estimates to a number of adjustments. Leaving aside the insufficient number of firms examined here, it is argued that some of these adjustments are inappropriate, and the result is to alter Gray and Officer's estimate from at least 1 to less than .82. Again, this is comparable with ESCOSA's estimate of .80.

The paper has also examined the analysis in NERA, to the extent that it deals with issues other than the judgements of other regulators. Five of their arguments are considered here. Of these, one is more comprehensively addressed by Gray and Officer, two are argued to be invalid, one to be irrelevant, and the remaining point to have been applied at the wrong level.

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