Report prepared for the
Australian Energy Regulator

Comments on the CEG Reports:

"Estimation of, and correction for, biases inherent in the Sharpe CAPM formula"

And

"An analysis of implied market cost of equity for Australian regulated utilities"

John C. Handley
University of Melbourne

Final
20 November 2008

1. INTRODUCTION

Pursuant to the National Electricity Rules, the Australian Energy Regulator (AER) is currently undertaking a review of the weighted average cost of capital (WACC) parameters to be adopted in determinations for electricity transmission and distribution network service providers. In this regard, the AER has requested a critique of two reports submitted by Competition Economists Group (CEG) entitled: "Estimation of, and correction for, biases inherent in the Sharpe CAPM formula"[1] and "An analysis of implied market cost of equity for Australian regulated utilities".[2] In particular, advice is sought on the following matters:

- whether the First CEG Report conclusively demonstrates that the Sharpe/Lintner model provides under-compensation for the required cost of equity; and

- whether the Second CEG Report conclusively demonstrates the case that the implied cost of equity is higher than the cost of equity that would be derived from the National Electricity Rules.

At the outset, it should be noted that the AER's review is limited to the individual WACC parameters rather than a review of the overarching framework in which the WACC is applied. For example, neither the use of the nominal post-tax framework or the use of the capital asset pricing model (CAPM) for calculating the cost of equity are subject to review by the AER.[3]

1 Competition Economists Group (2008a) and referred to here as the First CEG Report.
2 Competition Economists Group (2008b) and referred to here as the Second CEG report.
3 Australian Energy Regulator (2008 p.5).

2. THE FIRST CEG REPORT

The First CEG Report considers the most appropriate basis for estimating equity returns. In particular, CEG suggest:

(i) *"Our conclusion is that the Sharpe CAPM does not adequately describe how capital market's actually set firm's required equity return. Theoretical and empirical advances since 1964 have demonstrated that the Sharpe CAPM formula results in biased estimates of the required returns actually determined in capital markets. Specifically, the Sharpe CAPM underestimates the required return on equity with* $\beta_e < 1$ *and overestimates the required return on equity with* $\beta_e > 1$ *" (para.9).*

(ii) *"For the purposes of this report, we have replicated the Fama and Macbeth study using 44 years of monthly Australian return data from 1964 to 2007. We also find the same result as other researchers." (para.23).*

(iii) *The Fama and French three factor model is the model that best predicts the returns that are actually observed in capital markets" (para.15).*

(iv) *"These results create a strong presumption for the adoption of an equity beta of close to 1.0 when using the Sharpe CAPM formula – even if observed values for equity beta are materially different to 1.0" (para.2).*

There are two distinct issues here. First, taken together, statements (i) to (iii) seriously challenge the validity of using the Sharpe CAPM to estimate equity returns. Second, statement (iv) is suggested as a solution to correct the perceived bias which would otherwise result from using the Sharpe CAPM. Comments on each are set out below:

2.1 Is it Valid to Use the Sharpe CAPM to Estimate Equity Returns ?

CEG argue, on both empirical and theoretical grounds, that the answer is a clear no. In reaching this conclusion, CEG rely on the results of several well known international empirical studies – including Black, Jensen and Scholes (1972), Fama and MacBeth (1973), Fama and French (1992) and Campbell and Vuolteenaho (2004) – plus the results of its own empirical study, using Australian data. CEG also rely on a number of well known alternative asset pricing models which have been proposed as theoretical explanations of the empirical results – including the zero beta CAPM of Black (1972),[4] the intertemporal CAPM of Merton (1973)[5] and the three factor model of Fama and French (1992), (1993), (1996).

---

4 The Sharpe CAPM is an equilibrium asset pricing model which describes the relationship between the expected return on an asset and the risk of the return on that asset over a single (unspecified) period, in accordance with the following well-known pricing equation: $E\left(r_j\right) = r_f + \beta_j\left(E\left(r_M\right) - r_f\right)$ where $E\left(r_j\right)$ is the expected return on risky asset j, r_f is the risk free rate, $E\left(r_M\right) - r_f$ is the expected market risk premium and β_j is the beta of risky asset j with respect to the market portfolio M. The Sharpe CAPM may therefore be interpreted as a single factor model in the sense that, in equilibrium, expected returns are a function of a single factor – market risk. Intuitively, only systematic or market risk matters for pricing purposes since it is assumed that investors can fully diversify away all unsystematic risk at no cost. The Sharpe CAPM is based on a number of simplifying assumptions including: (i) competitive and frictionless markets; (ii) a single exogenously determined risk free interest rate at which investors may borrow or lend without restriction; and (iii) no restrictions on short selling of risky assets. In the absence of a risk free asset, Black (1972) shows that the equilibrium relationship between the expected return on an asset and its beta takes the same functional form as the Sharpe CAPM, but with the risk free rate, r_f replaced by the expected return on the 'zero-beta portfolio', i.e. $E\left(r_j\right) = E\left(r_z\right) + \beta_j\left(E\left(r_M\right) - E\left(r_z\right)\right)$. As its name suggests, the beta of the zero-beta portfolio, with respect to the market portfolio M, is equal to zero. As Black (1972, p.450) states, "Thus the relation between the expected return on an efficient portfolio k and its β_k is the same whether or not there is a riskless asset. If there is, then the intercept of the relationship is r_f. If there is not, then the intercept is $E\left(r_z\right)$". Black (1972) also considers the case where investors can lend but not borrow at the risk free rate and shows that the same expected return-beta relationship holds (for risky assets and portfolios of risky assets only) with $r_f < E\left(r_z\right) < E\left(r_M\right)$. In other words, if there are no restrictions on borrowing at the risk free rate then $r_f = E\left(r_z\right)$ otherwise, the intercept of the expected return-beta line is shifted up which results in a relationship that is "flatter" than otherwise suggested by the Sharpe CAPM. The Black CAPM may therefore be interpreted as a two factor model in the sense that, in equilibrium, expected returns are a function of two factors – market risk and the return on the zero-beta portfolio.

5 Merton (1973) extends the CAPM to a multi-period framework in which investors are assumed to maximize the expected utility of lifetime consumption. The resultant pricing equation is a multi-beta CAPM whereby the expected return on an asset is a function of the risk premia associated with an <u>assumed</u> set of state variables which describe the future investment and consumption opportunity sets. According to Brennan (1992, p.290), "In the absence of prior information about the relevant state variables, this model is empirically indistinguishable from the Arbitrage Pricing Theory".

Despite the purported strength of CEG's conclusions, the following considerations are also relevant:

- The empirical evidence presented by CEG is not new. [6]

- There is no consensus as to how the empirical evidence should be interpreted.

  For example, Roll (1977) argues the choice between alternative forms of the CAPM is extremely sensitive to the choice of the proxy for the market portfolio and in particular, while the results of Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) appear to support the Black CAPM over the Sharpe CAPM, "their tests results are fully compatible with the Sharpe-Lintner model and a specification error in the measured 'market' portfolio" (p.131).[7] Roll and Ross (1994) similarly suggest the results of Fama and French (1992) can alternatively be explained by an inefficient market proxy while Kothari, Shaken and Sloan (1995) suggest the Fama-French results are partly explained by data frequency and survivorship bias.

- Roll (1977) argues that the market portfolio, which includes all assets, can never be empirically identified and therefore the CAPM can never be empirically tested. This limitation is acknowledged by Fama and French (2004, p.25) who state "The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid tests of the model".

- The Fama-French three factor model was derived empirically, rather than starting from a theoretical base.[8] Notwithstanding subsequent papers, such as Berk, Green and Naik (1999) may provide some intuition behind the model, its

---

[6] Excluding the results of its own study.

[7] Roll (1977) states further that "For the Black, Jensen and Scholes data, for example, there was a mean variance efficient 'market' proxy that supported the Sharpe-Lintner model *perfectly* and that had a correlation of 0.895 with the market proxy actually employed." (p.131)

[8] According to Fama and French (2004, 39), "From a theoretical perspective, the main shortcoming of the three-factor model is its empirical motivation. The small-minus-big (SMB) and the high-minus-low (HML) explanatory returns are not motivated by predictions about state variables of concern to investors. Instead they are brute force constructs meant to capture the patterns uncovered by previous work on how average stock returns vary with size and the book-to-market equity ratio".

empirical genesis arguably introduces a "black-box" element into its application, since there is insufficient evidence, and certainly no consensus, at this stage to conclude what the factors actually represent.[9]

To summarise according to Copeland, Weston and Shastri (2005, p.164), "In fact, researchers have been working on tests of the CAPM for nearly 40 years, and no conclusive evidence has been published to date – the jury is still out".

2.2 How Should Returns Be Estimated, if Not by the Sharpe CAPM ?

CEG claim that the Sharpe CAPM is a flawed model for estimating equity returns and in particular, beta has no relevance:

> *"there does not appear to be any significant relation between* β_e *and equity returns in the Australian market" (para.31).*

Two possible solutions are suggested by CEG. The first is to add an increment to the risk free rate equal to the expected market risk premium. The second is to set the beta equal to one – the effect of each would be same i.e. the estimated equity return would be equal to the estimated return on the market portfolio.

Even if one was to accept CEG's claim that the Sharpe CAPM is a flawed model for estimating equity returns, there are still two critical difficulties with their proposed "solutions".

- First, there is an implicit inconsistency in arguing on the one hand that beta and therefore the Sharpe CAPM is irrelevant, but then seeking to use the empirical results of a regression of (portfolio) returns against (portfolio) betas as the basis for estimating equity returns. As Fama and French (2004) state, "If betas do not suffice to explain expected returns, the market portfolio is not efficient and the

---

9 Another possible explanation for the size and book-to-market factors comes from Campbell and Vuolteenaho (2004) who suggest that the single beta of the Sharpe CAPM should be decomposed into two betas – a (bad) cashflow beta and a (good) discount rate beta.

CAPM is dead in its tracks" (p.36) – in other words, if beta is deemed irrelevant, then any analysis of returns based on beta is also irrelevant.

- Second, the most appropriate way to proceed would be to completely replace the Sharpe CAPM with an appropriate alternative asset pricing model. Simply making an ad hoc adjustment to the CAPM determined rate of return would by definition be arbitrary and therefore could not be justified (other than on policy grounds). Equally, if some adjustment is argued for on the basis of consistency with some other model, then the better approach would be to use that other model. For example, CEG propose the following adjustment to the Sharpe CAPM:

$$E\left(r_j\right) = r_f + \alpha + \beta_j\left(E\left(r_M\right) - \left(r_f + \alpha\right)\right) \qquad (1)$$

where α is "an *appropriate* positive amount … [added] to the risk free rate" [Emphasis added here], (para.30). Herein lies the problem. This is <u>not</u> the Black CAPM – rather it is the Sharpe CAPM with an arbitrary adjustment. In contrast the Black CAPM clearly requires the risk free rate to be replaced by the expected return on the zero beta portfolio, $E\left(r_z\right)$. However, CEG does not identify the zero beta portfolio let alone directly estimate its expected return.

So the key issue for consideration would then become which asset pricing model should be used ?

Of course there are many potential candidates to choose from – including Black (1972), Merton (1973), Fama and French (1992), (1993), (1996) and Campbell and Vuolteenaho (2004) – each with its perceived advantages and disadvantages and importantly, each with its set of estimation issues. Further, it does not follow that returns estimated using an alternative asset pricing model will automatically be higher than returns estimated using the Sharpe CAPM.

In summary, at this stage, a consensus on the status of the CAPM does not exist and so, in my opinion, it would be premature to jettison the CAPM as the benchmark in setting rates of return. However, if one adopts the view that the Sharpe CAPM is flawed then the appropriate response is to choose a new model.

3. THE SECOND CEG REPORT

The Second CEG Report presents an analysis of the implied cost of equity of six listed regulated utilities using the dividend growth model (DGM), based on stock prices and analysts' forecasts of future dividends as at June-July 2008. Based on the results, CEG suggest:

> *"The key finding is that, for plausible ranges of expected future dividend growth, the market discount rate is higher than the discount rate that would be derived using the National Electricity Rules (NER) for transmission".(p.3)*

which CEG take to be 12.5% pa. In particular, assuming a 4.1% pa increase in dividends out to 2012,[10] CEG estimate that:

> *"in order to make the observed price of equity consistent with the NER assumed cost of equity it must the case that dividends are expected to fall by more than 2% pa (more than 4.5% pa in real terms) post 2012" (para.11).*

There are two serious limitations with the CEG analysis.

First, the DGM is an inappropriate model to use in the absence of information concerning the underlying free cash flow of the firm. The standard approach to discounted cash flow valuation involves discounting the stream of the free cash flow (or free cash flow to equity) generated by the firm. The DGM may be used in place of the free cash flow approach when dividends are a proxy for free cash flow to equity – otherwise valuation errors will result. For example, if the forecast dividend stream is greater than the forecast free cash flow to equity stream then the DGM valuation will be too high, since the dividend stream will be unsustainable. Similarly, if the forecast dividend stream is less than the forecast free cash flow to equity stream then the DGM

10 Competition Economists Group (2008, para 17).

valuation will be too low, since accumulated surplus free cash flow will not be taken into account. There is insufficient information in the Second CEG Report concerning the forecast free cash flow of each firm to assess the appropriateness of the dividend forecasts upon which the CEG analysis is based. Further, there is insufficient information concerning the basis upon which the analysts have made their dividend forecasts.

Second, different combinations of growth, dividend and cost of equity assumptions can lead to the same value and these values can be very sensitive to the assumed inputs. For example, based on data presented in Table 1[11], the total next period dividend for all six firms is \$1.247 and the total current price is \$11.67. If one assumes that the firms will maintain the dividend stream from 2008 in real terms in perpetuity, then the implied cost of equity, assuming an inflation rate of 2.5% pa in perpetuity is $k_e = \frac{1.247}{11.67} + 0.025 = 0.132$ or 13.2% which is above the CEG assumed NER determined rate of 12.5%. However, if the dividend next period has inadvertently been overestimated by say 10%, and the long run inflation rate is 2% pa instead of 2.5% pa then the implied cost of equity is $k_e = \frac{1.122}{11.67} + 0.020 = 0.116$ or 11.6%, which is below the CEG assumed NER determined rate of 12.5%.

In summary, in my opinion the DGM is only appropriate for "back of the envelope" type valuations and in any case, should be treated with much caution.

11 Competition Economists Group (2008, para 6).

REFERENCES

Australian Energy Regulator, 2008, Review of the Weighted Average Cost of Capital (WACC) Parameters for Electricity Transmission and Distribution: Issues Paper, Commonwealth of Australia, Canberra, August.

Berk, J., R. Green and V. Naik, 1999, Optimal Investment, Growth Options and Security Returns, Journal of Finance, 54, 1553-1607.

Black, F., 1972, Capital Market Equilibrium with Restricted Borrowing, Journal of Business, 45, 444-454.

Black, F., M.C. Jensen and M. Scholes, 1972, The Capital Asset Pricing Model: Some Empirical Tests, in M.C. Jensen (ed), Studies in the Theory of Capital Markets, Praeger, NY.

Brennan, M.J., 1992, Capital Asset Pricing Model in The New Palgrave Dictionary of Money and Finance, P. Newman, M. Milgate and J. Eatwell (eds), MacMillan Press Limited, London.

Campbell, J.Y. and T. Vuolteenaho, 2004, Bad Beta, Good Beta, American Economic Review, 94, 1249-1275.

Competition Economists Group, (2008a), Estimation of, and correction for, biases inherent in the Sharpe CAPM formula, Report for the Energy Networks Assocaition, Grid Australia and APIA, 15 September.

Copeland, T.E., J.F. Weston and K. Shastri, 2005, Financial Theory and Corporate Policy, 4th edition, Pearson Education Inc.

Competition Economists Group, (2008b), An analysis of implied market cost of equity for Australian regulated utilities, Report for the APIA, ENA and Grid Australia, 14 September.

Fama, E.F. and K.R. French, 1992, The Cross-section of Expected Stock Returns, Journal of Finance, 47, 427-465.

Fama, E.F. and K.R. French, 1993, Common Risk Factors in the Returns on Stocks and Bonds, Journal of Financial Economics, 33, 3-56.

Fama, E.F. and K.R. French, 1996, Multifactor Explanations of Asset Pricing Anomalies, Journal of Finance, 51, 55-84.

Fama, E.F. and K.R. French, 2004, The Capital Asset Pricing Model: Theory and Evidence, Journal of Economic Perspectives, 18, 25-46.

Fama, E.F. and J.D. MacBeth, 1973, Risk, Return and Equilibrium, Journal of Political Economy, 81, 607-636.

Kothari, S.P., J. Shanken and R. Sloan, 1995, Another Look at the Cross-section of Expected Returns, Journal of Finance, 50, 185-224.

Merton, R.C., An Intertemporal Capital Asset Pricing Model, Econometrica, 41, 867-887.

Roll, R., 1977, A Critique of the Asset Pricing Theory's Tests Part I: On Past and Potential Testability of the Theory, Journal of Financial Economics, 4, 129-176.

Roll, R. and S.A. Ross, 1994, On the Cross-sectional relation Between Expected returns and Betas, Journal of Finance, 49, 101-121.