NERA
ECONOMIC CONSULTING

Review of Cost of Equity Models

A report for the Energy Networks Association

June 2013

Project Team

Simon Wheatley

Brendan Quach

NERA Economic Consulting
Darling Park Tower 3
201 Sussex Street
Sydney NSW 2000
Tel: 61 2 8864 6500 Fax: 61 2 8864 6549
www.nera.com

Contents

List of Tables

List of Figures

Executive Summary

This report has been prepared for the Energy Networks Association (ENA) by NERA Economic Consulting (NERA). The ENA has asked NERA to provide a review of the empirical evidence on:

- the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM);
- the Black CAPM;
- the Fama-French three-factor model;
- the dividend growth model (DGM); and
- independent expert reports.

In each case we have been asked to assess the strengths and weaknesses of each approach to the issue of estimating the cost of equity for a regulated energy utility.

Attached to each pricing model are strengths and weaknesses. These strengths and weaknesses depend on the *bias* that may result from the use of a pricing model and the *precision* with which the use of a model will allow one to estimate the cost of equity. An estimator of a parameter is said to be unbiased if the expected value of the estimator matches the parameter and is said to be biased if the expected value differs from the parameter.[1] The precision of a random variable is the reciprocal of its variance.[2]

All else constant an unbiased estimator will be preferred to a biased estimator and all else constant a more precise estimator will be preferred to a less precise estimator. Restrictive models are likely to produce estimates that are more precise but also estimates that may be biased.[3] Less restrictive models are likely to produce estimates that are less precise but also estimates that are less likely to be biased.[4] Similarly, models that contain more parameters,

---

1 See, for example:

Hamilton, J.D., *Time series analysis*, Princeton University Press, Princeton, NJ, 1994, page 741.

2 This definition, standard in the statistics literature, differs from the Oxford Dictionary definition of precision which is:

> 'accuracy or exactness.'

In statistics a precise estimator can be exact but inaccurate. As Davidson and MacKinnon note, however,

> 'it is sometimes more intuitive to think in terms of precision than in terms of variance.'

We agree and so use the terms precise and precision to render our discussion easier to follow.

Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 144.

Fowler, F.G. and H.W. Fowler, *Pocket Oxford Dictionary*, Oxford University Press, Oxford, 1966, page 623.

3 See, for example:

Toro-Vizcorrondo, C. and T.D. Wallace, *A test of the mean square error criterion for restrictions in linear regression*, Journal of the American Statistical Association, 1968, pages 558-572.

4 The Black CAPM is a less restrictive model than the SL CAPM. The SL CAPM restricts the zero-beta premium to be zero while the Black CAPM does not.

but that are not necessarily less restrictive, are likely to produce estimates that are less precise but also estimates that are less likely to be biased.[5]

In principle, one may be willing to trade off bias for precision. In practice, though, one may wish to demonstrate that a trade-off will convey benefits. Demonstrating that there will be benefits from trading off bias for precision may be difficult.[6]

We conclude that the SL CAPM:

- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a low-beta or value stock (high-beta or growth stock); but
- is likely to provide cost of equity estimates that are more *precise* than estimates produced using the Black CAPM and Fama-French three-factor model because the SL CAPM is a restrictive model that contains few parameters.

A stock's beta is a measure of the sensitivity of the stock's return to the return on the market portfolio.[7] A value (growth) stock is a stock whose book value is high (low) relative to its market value.

We conclude that the Black CAPM:

- is likely to provide an approximately *unbiased* estimate of the return required on a stock that is neither a value nor a growth stock; but
- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a value stock (growth stock); and
- because it is a more general model than the SL CAPM, it will likely produce less *precise* estimates than the SL CAPM.

We conclude that the Fama-French three-factor model:

- is likely to provide an *unbiased* estimate of the return required on a stock that is a value nor a growth stock and that is neither a low-market-beta nor high-market-beta stock; but

---

5 The Fama-French three-factor model contains more parameters than the SL CAPM. So it is tempting to infer that the Fama-French model is a less restrictive model than the SL CAPM. This, however, is not the case. The two models are not nested – meaning one model is not a special case of the other. For a discussion of what it means for models to be nested, see:

Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 381.

6 See, for example:

Wheatley, S.M., *Evaluating asset pricing models*, paper presented at the American Finance Association Meetings, Chicago, IL, 1998.

7 See, for example:

Sharpe, W.F. and G.J. Alexander, *Fundamentals of investments*, Prentice Hall, Englewood Cliffs, NJ, 1989, page 644.

- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a low-market-beta stock (high-market-beta-stock); and
- because it is a model that contains more parameters than the SL CAPM, will likely produce less *precise* estimates of the cost of equity than the SL CAPM.

The DGM delivers the single internal rate of return that will discount the future dividends that a stock or portfolio is expected to generate back to its current market price. This internal rate of return will be a complicated average of the expected returns to the stock or portfolio over the next year and over all future years. The major source of uncertainty in determining the return that the DGM will deliver is in determining how the dividends, that the stock or portfolio will generate, will grow over time. We conclude that the use of the DGM:

- is likely to produce estimates of the return required on a stock that are, on average through time, *unbiased* but that may be, at any particular point in time, *biased*; and
- will deliver estimates of the return required on a stock that are *precise* if an estimate of the future growth in dividends can be constructed that is *precise*.

Independent experts often use the SL CAPM to estimate the cost of equity but frequently make adjustments that take the final cost of equity that they choose away from that implied by a sole use of the model. It is reasonable to assume that the adjustments that experts make are designed to reduce the bias that can result from using the SL CAPM. Use of an adjustment, however, may lower the precision with which the model estimates the cost of equity. We have no information on how experts trade off between bias and precision but we think it likely that experts provide estimates of the cost of equity that:

- are likely to be less *biased* than estimates produced using the SL CAPM; but
- are likely to be less *precise*.

We note, however, that few expert reports have been produced in recent years for regulated energy infrastructure in Australia. Thus it may be difficult to extract current estimates of the cost of equity for a regulated utility directly from an expert report or reports. We note, on the other hand, that one can extract important information from independent expert reports that do not focus on regulated energy infrastructure about:

- the choices that practitioners make in selecting a value for the risk-free rate;
- the views of practitioners on the expected return on the market; and
- the views of practitioners on whether the market places a value on imputation credits distributed.

1. Introduction

This report has been prepared for the Energy Networks Association (ENA) by NERA Economic Consulting (NERA). The ENA has asked NERA to provide a review of the empirical evidence on:

- the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM);
- the Black CAPM;
- the Fama-French three-factor model;
- the dividend growth model (DGM); and
- independent expert reports.

In each case we have been asked to assess the strengths and weaknesses of each approach to the issue of estimating the cost of equity for a regulated energy utility.

This report recognises that the task that the regulator faces is to determine what cost of equity the market is currently using for a regulated energy utility, and that one way of doing so will be to use a theoretical model, but acceptable suitable alternative method would be to examine market practice. In a very similar way regulators often do not attempt to determine from first principles what the term structure of interest rates should be but instead use interpolation and extrapolation to determine an appropriate cost of debt. Regulators in so doing accept that the market has correctly determined the rates that can be observed and do not challenge these rates. The use of interpolation and extrapolation is, of course, closely linked to the no-arbitrage principle.[8] As we will make clear, the no-arbitrage principle provides a theoretical foundation for both the Fama-French three factor model and the DGM.[9]

In this report we confine our attention to domestic pricing models as in the past regulators have not considered international pricing models.

The remainder of this report is structured as follows:

- section 2 provides a description of the theory underlying the SL CAPM and reviews the evidence on the performance of empirical versions of the model;

---

[8] If, for example, a one-year zero-coupon bond with a face value of $100 sells for $90 and a two-year zero-coupon bond with a face value of $100 sells for $80, then, by interpolation, a two-year annuity paying $50 at the end of each year must sell for $85. This must also be true, though, to avoid arbitrage opportunities.

[9] See:

Cochrane, John H., *Asset pricing*, Princeton University Press, 2001, page 442.

Easton, P., G. Taylor, P. Shroff and T. Sougiannis, *Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment*, Journal of Accounting Research 40, 2002, page 660.

Rubinstein, M., *The valuation of uncertain income streams and the pricing of options*. Bell Journal of Economics, 1976, pages 407-25.

- section 3 provides a description of the theory underlying the Black CAPM and reviews the evidence on the performance of empirical versions of this alternative version of the CAPM;
- section 4 provides a description of the theory underlying the Fama-French three-factor model and reviews the evidence on the performance of the model;
- section 5 describes how one can use the DGM to estimate the cost of equity for a regulated utility and assesses the costs and benefits of doing so;
- section 6 assesses the use of independent expert reports to determine the cost of equity; and
- section 7 offers conclusions.

In addition Appendix A provides the terms of reference for this report while Appendix B provides the curricula vitae of the two authors of the report.

1.1. Statement of Credentials

This report has been jointly prepared by **Simon Wheatley** and **Brendan Quach**.

Simon Wheatley is a Special Consultant with NERA, and was until 2008 a Professor of Finance at the University of Melbourne. Since 2008, Simon has applied his finance expertise in investment management and consulting outside the university sector. Simon's interests and expertise are in individual portfolio choice theory, testing asset-pricing models and determining the extent to which returns are predictable. Prior to joining the University of Melbourne, Simon taught finance at the Universities of British Columbia, Chicago, New South Wales, Rochester and Washington.

Brendan Quach is a Senior Consultant at NERA with eleven years experience as an economist, specialising in network economics and competition policy in Australia, New Zealand and Asia Pacific. Since joining NERA in 2001, Brendan has advised a wide range of clients on regulatory finance matters, including approaches to estimating the cost of capital for regulated infrastructure businesses.

In preparing this report, the joint authors (herein after referred to as 'we' or 'our' or 'us') confirm that we have made all the inquiries that we believe are desirable and appropriate and that no matters of significance that we regard as relevant have, to our knowledge, been withheld from this report. We acknowledge that we have read, understood and complied with the Federal Court of Australia's *Practice Note CM 7, Expert Witnesses in Proceedings in the Federal Court of Australia*. We have been provided with a copy of the Federal Court of Australia's *Practice Note CM 7, Expert Witnesses in Proceedings in the Federal Court of Australia*, dated 1 August 2011, and our report has been prepared in accordance with those guidelines.

We have undertaken consultancy assignments for the Energy Networks Association in the past. However, we remain at arm's length, and as independent consultants.

2. Capital Asset Pricing Model

The AER has for some years relied on the Sharpe-Lintner (SL) CAPM to compute an estimate of the cost of equity – even when it has had the discretion to use another model.[10]

The benefit of using the SL CAPM is that it is a simple model that requires that one estimate few parameters – this implies that estimates of the cost of equity produced using the model may be relatively *precise*. The precision of a random variable is the reciprocal of its variance.[11]

However, there is a substantial amount of evidence against the SL CAPM as the AER uses it – it tends to underestimate (overestimate) the return required on low-beta (high-beta) stocks. The model also tends to underestimate (overestimate) the returns required on value (growth) and small-cap (large-cap) stocks.[12] This evidence implies that estimates of the cost of equity produced using the model may be *biased*. An estimator of a parameter is said to be unbiased if the expected value of the estimator matches the parameter and is said to be biased if the expected value differs from the parameter.[13]

We begin by describing how the model works.

2.1. Theory

Sharpe (1964) and Lintner (1965) show that if risk-averse investors:[14]

(i) choose between portfolios on the basis of the mean and variance of each portfolio's return measured over a single period;

(ii) share the same investment horizon and beliefs about the distribution of returns;

(iii) face no taxes (or the same rate of tax on all forms of income) and there are no transaction costs; and

(iv) can borrow or lend freely at a single risk-free rate,

---

[10] See, for example, the AER's 2010 Jemena final decision in which it declined to use the Fama-French three-factor model and chose instead to use the SL CAPM.

AER, *Final decision: Jemena Gas Networks Access arrangement proposal for the NSW gas networks 1 July 2010 – 30 June 2015*, June 2010, page 158.

[11] Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 144.

[12] A value (growth) stock is a stock whose book value is high (low) relative to its market value.

[13] See, for example:

Hamilton, J.D., *Time series analysis*, Princeton University Press, Princeton, NJ, 1994, page 741.

[14] As we emphasise in section 3, the Black CAPM relaxes assumption (iv). The Black CAPM, however, does require that no restrictions be placed on short sales.

then the market portfolio of risky assets must be mean-variance efficient.[15] A portfolio that is mean-variance efficient is a portfolio that has the highest mean return for a given level of risk, measured by variance of return.

If the market portfolio is mean-variance efficient, the following condition will hold:

$$\mathrm{E}(r_j) = r_f + \beta_j[\mathrm{E}(r_m) - r_f], \quad (1)$$

where:

$\mathrm{E}(r_j)$ = the mean return on asset j;

r_f = the risk-free rate;

β_j = asset j's beta, which measures the contribution of the asset to the risk, measured by standard deviation of return, of the market portfolio; and

$\mathrm{E}(r_m)$ = the mean return to the market portfolio of risky assets.

So the SL CAPM predicts that:

- there should be a positive linear relation between risk, measured by beta, and return;
- the price of risk should be the market risk premium, $MRP = \mathrm{E}(r_j) - r_f$; and
- the return required on a zero-beta asset should be the risk-free rate.

In the SL CAPM, a risk-averse investor will never invest solely in a single risky asset but rather will hold a share of the market portfolio. So, in the model, an investor cares not about how risky an individual asset would be if held alone, but by how the asset contributes to the risk of the market portfolio. Beta measures this contribution.

As Roll (1977) makes clear, the SL CAPM predicts that the market portfolio of *all* risky assets must be mean-variance efficient – it does not predict that the market portfolio of stocks must be mean-variance efficient.[16] The empirical version of the model that the AER and others use measures the risk of an asset relative to a portfolio of stocks alone. Stocks have readily available and transparent prices relative to other risky assets such as debt, property and human capital. Stocks, though, make up a relatively small fraction of all risky assets, so the return to a portfolio of stocks need not track closely the return to the market portfolio of *all* risky assets.[17] Thus the empirical version of the SL CAPM that the AER actually employs

---

[15] Sharpe, William F., *Capital asset prices: A theory of market equilibrium under conditions of risk*, Journal of Finance 19, 1964, pages 425-442.

Lintner, John, *The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets*, Review of Economics and Statistics 47, 1965, pages 13-37.

[16] Roll, R., *A critique of the asset pricing theory's tests: Part I*, Journal of Financial Economics 4, 1977, pages 129-176.

[17] The mean value of an Australian household's direct investment in stocks in 2010 was $37,505 and the mean value of the household's superannuation account – part of which would have been invested in stocks – was $142,429. The mean net wealth of a household in 2010 was $683,805. Thus the average Australian household in 2010 invested no more than 100 × (37,505 + 142,429)/683,805 = 26 per cent of its net wealth in stocks. See:

differs from the theoretical model proposed by Sharpe and Lintner. The empirical version of the model that the AER employs does closely resemble, though, the version that academic work tests.[18]

Roll (1977) points out that difficulties in measuring the return to the market portfolio of *all* risky assets mean that it is not possible to test the SL CAPM.[19] One may be able to reject an empirical version of the model that uses the market portfolio of stocks as a proxy for the market portfolio of all risky assets, but this rejection will not imply that the theoretical model itself is wrong. The issue that concerns us, though, is not whether the theoretical SL CAPM is correct, but whether the empirical version of the SL CAPM applied by the AER works. In other words, we are interested in whether the empirical version of the model that the AER uses allows the AER to generate unbiased and precise estimates of the return required by a regulated energy utility.

2.2. Evidence

Since our interest is in whether the empirical version of the SL CAPM applied by the AER works, all references to the SL CAPM from here onwards will be to the empirical version of the model that the AER uses unless stated otherwise. Again, the AER and its advisors use a value-weighed portfolio of stocks as a proxy for the market portfolio.[20]

Again, the SL CAPM predicts that:

- there should be a positive linear relation between risk, measured by beta, and return;
- the price of risk should be the *MRP*; and
- the return required on a zero-beta asset should be the risk-free rate.

We will review first the evidence that exists on the relation between risk, measured by an estimate of beta, and return.

Melbourne Institute, *A statistical report on waves 1 to 10 of the Household, Income and Labour Dynamics in Australia Survey*, 2013, page 83.

[18] The only differences between the version of the model that the AER employs and the version that academic work typically tests are that (i) academic work typically employs a one-month bill rate as a measure of the risk-free rate whereas the AER uses a 10-year bond yield and (ii) academic work typically assigns no value to imputation credits whereas the AER assigns a value to imputation credits distributed. An exception to this rule is a paper by Lajbcygier and Wheatley (2012) that tests the model that the AER uses and finds evidence against the proposition that the market places a value on credits distributed and against the hypothesis that a zero-beta portfolio earns the risk-free rate.

Lajbcygier, P. and S.M. Wheatley, *Imputation credits and equity returns*, Economic Record, 2012, page 487.

[19] Roll, R., *A critique of the asset pricing theory's tests: Part I*, Journal of Financial Economics 4, 1977, pages 129-176.

[20] See, for example:

Henry, Olan T., *Econometric advice and beta estimation*, Attachment C to the AER's *Explanatory Statement: Electricity transmission and distribution network service provider, review of the weighted average cost of capital (WACC) parameters*, 2008.

Henry, Olan T., *Estimating beta*, Attachment C to the AER's *Final Decision: Electricity transmission and distribution network service providers, review of the weighted average cost of capital (WACC) parameters*, 2009.

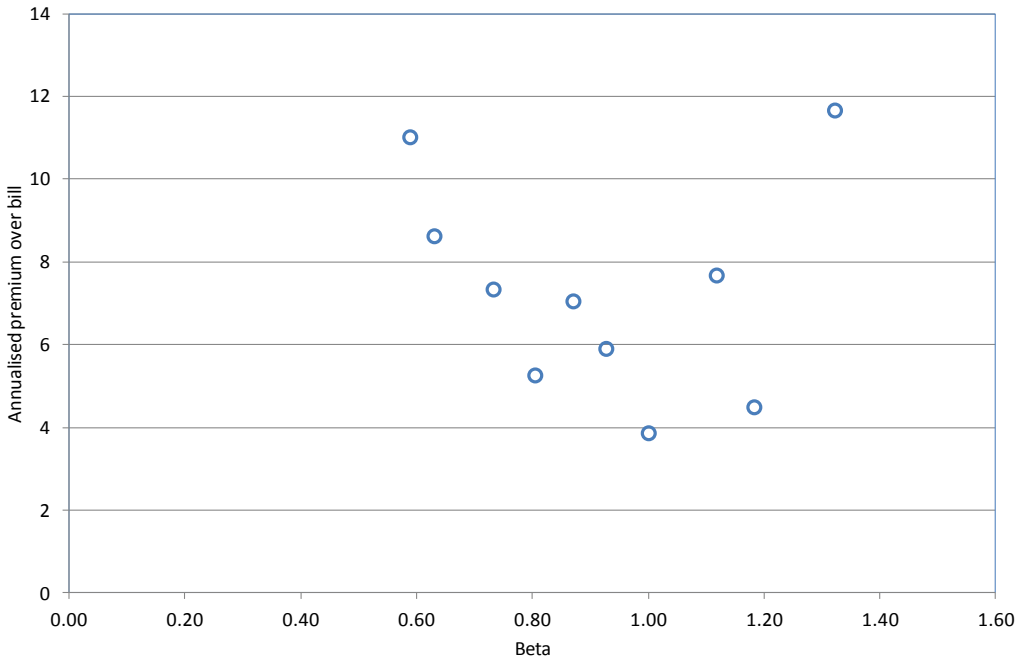
2.2.1. The relation between beta and the cost of equity

A large body of work from both Australia and the US indicates that:

- there is little relation between the return to a stock or portfolio of stocks and an estimate of its beta; and
- an estimate of the return required on a zero-beta asset typically exceeds the risk-free rate.

As an example, Figure 2.1 below, taken from NERA (2013), shows that there is little relation between the return to a portfolio of Australian stocks and an estimate of its beta.[21] The figure plots the average returns in excess of the risk-free rate to 10 portfolios of Australian stocks formed on the basis of past estimates of beta against estimates of their betas for the period 1974 to 2012.[22] The figure also suggests that an estimate of the return required on a zero-beta portfolio in excess of the risk-free rate will exceed zero. Put another way, the figure suggests that an estimate of the return required on a zero-beta portfolio will exceed the risk-free rate.

Figure 2.1
Annualised premium over bill against an estimate of beta for 10 Australian portfolios formed on past estimates of beta: 1974-2012



Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly average return to a portfolio in excess of the one-month risk-free rate multiplied by 12.

[21] NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, June 2013.

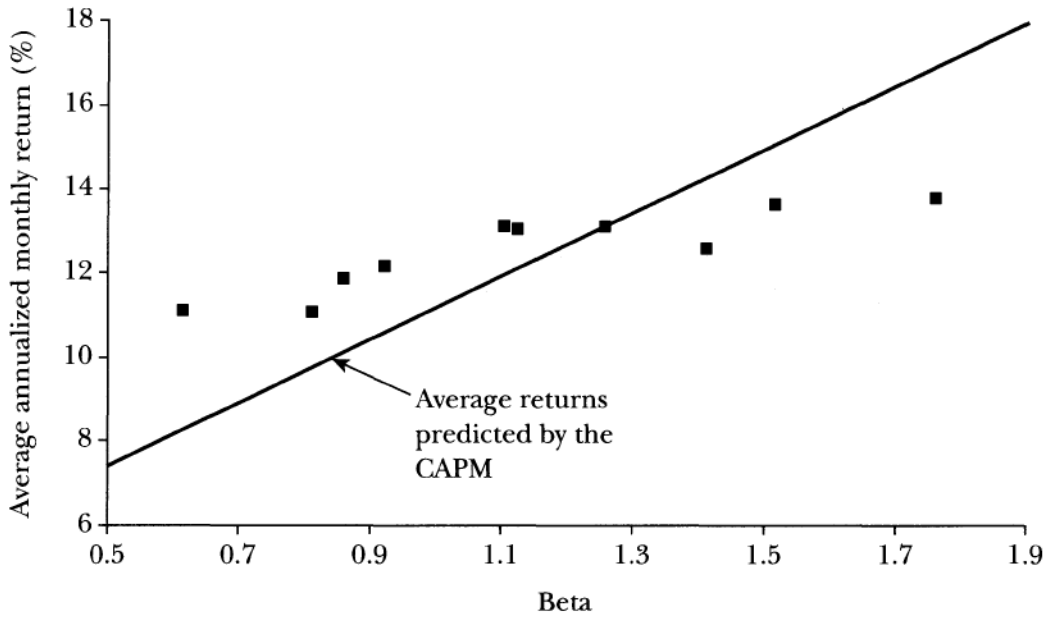
[22] Figure 2.1 uses the one-month bill rate as a measure of the risk-free rate while the AER uses the yield on a 10-year Commonwealth Government Security. Replacing the one-month risk-free rate with the monthly yield on a 10-year bond, however, will have no impact on the slope of a line that best fits the data and only a negligible impact on the intercept.

As another example, Figure 2.2 below, taken from Fama and French (2004), shows that there is little relation between the return to a portfolio of US stocks and an estimate of its beta.[23] The figure plots the average returns to 10 portfolios of US stocks formed on the basis of past estimates of beta against estimates of their betas for the period 1928 to 2003. The figure also suggests that the return required on a zero-beta portfolio will exceed the average risk-free rate.[24]

Fama and French (2004) summarise the evidence that Figure 2.2 provides in the following way:[25]

> 'the relation between beta and average return for the ten portfolios is much flatter than the Sharpe-Lintner CAPM predicts. The returns on the low beta portfolios are too high, and the returns on the high beta portfolios are too low. For example, the predicted return on the portfolio with the lowest beta is 8.3 percent per year; the actual return is 11.1 percent. The predicted return on the portfolio with the highest beta is 16.8 percent per year; the actual is 13.7 percent.'

Figure 2.2
Average annualized monthly return versus an estimate of beta for 10 US portfolios formed on past estimates of beta: 1928-2003



Source: Fama, E. and K. French, The Capital Asset Pricing Model: Theory and evidence, Journal of Economic Perspectives, 2004, pages 25-46.

---

[23] Fama, E. and K. French, *The Capital Asset Pricing Model: Theory and evidence*, Journal of Economic Perspectives, 2004 pages 25-46.

[24] The annualised average holding-period returns to US Treasury bills, US government intermediate-term bonds and US government long-term bonds from 1928 to 2003 are 3.70, 5.38 and 5.51 per cent. See:

Morningstar, Ibbotson SBBI Valuation Yearbook, 2012.

[25] Fama, E. and K. French, *The Capital Asset Pricing Model: Theory and evidence*, Journal of Economic Perspectives, 2004 page 33.

Table 2.1 provides estimates of the difference between the mean return to a zero-beta portfolio and the risk-free rate. The difference between the mean return to the market portfolio and the risk-free rate is labelled the market risk premium and so we will label the difference between the mean return to a zero-beta portfolio and the risk-free rate the 'zero-beta premium'. The SL CAPM predicts that the mean return to a zero-beta portfolio should match the risk-free rate. In other words, the SL CAPM predicts that the zero-beta premium should be zero. Table 2.1 indicates that there is a lot of evidence against the model both in Australian data and in US data. The zero-beta premium lies significantly above zero.

Table 2.1 also provides estimates of the slope of the line that best fits a scatter plot of the average returns to a cross-section of portfolios against estimates of their betas. We label an estimate of this difference the empirical price of risk. Table 2.1 indicates that while there is evidence of a significant positive relation between risk, measured by beta, and return in US data in the earlier part of the last century, there is no evidence of a positive relation between risk, measured by beta, and return in the latter part of the last century and the start of this century in either Australian or US data.

2.2.2. The relation between book-to-market, size and the cost of equity

Besides predicting that there should be a positive relation between risk, measured by beta, and return, the SL CAPM also predicts that the relation should be linear. In other words, the SL CAPM predicts that conditional on an asset's beta, no other variable should be related to the return required on the asset. There is a substantial amount of evidence against this prediction as well. Value stocks – that is high book-to-market stocks – and low-cap stocks tend to earn more than the SL CAPM predicts that they should earn.

Figure 2.3 below summarises evidence that Brailsford, Gaunt and O'Brien (2012) provide using Australian data.[26] The figure plots SL CAPM alphas against book-to-market and size for 25 Australian portfolios formed on the basis of book-to-market and size. An asset's alpha is a measure of the error with which a model prices the asset. It is the difference between the mean return to the asset and the return that the model predicts that the asset should on average earn. If an asset has a positive alpha, the model underestimates the return that the market requires the asset earn. If an asset has a negative alpha, the model overestimates the return that the market requires on the asset.

Figure 2.3 shows that value stocks – that is, high book-to-market stocks – have positive alphas and growth stocks – that is, low book-to-market stocks – have negative alphas. In other words, value stocks tend to earn higher returns than the SL CAPM predicts should be the case and growth stocks tend to earn less than the SL CAPM predicts should be the case. The evidence that Brailsford, Gaunt and O'Brien (2012) provide indicates that the SL CAPM underestimates the returns required on value stocks and overestimates the returns to growth stocks. Tests that Brailsford, Gaunt and O'Brien conduct of the hypothesis that the SL CAPM alphas attached to the 25 portfolios are simultaneously zero reject the null at conventional significance levels.

[26] Brailsford, T., C. Gaunt and M. O'Brien, *Size and book-to-market factors in Australia*, Australian Journal of Management, 2012, pages 261-281.

Table 2.1
Summary of existing evidence on the CAPM[27]

Study	Period	Zero-beta premium	Empirical price of risk
Panel A: US evidence			
Fama and MacBeth (1973) 20 beta-sorted portfolios	1935-1968	5.76 (2.26)	10.20 (3.95)
Campbell and Vuolteenaho (2004) 25 book-to-market- & size- & 20 beta-sorted portfolios	1929-1963	2.76 (3.36)	6.12 (5.52)
Campbell and Vuolteenaho (2004) 25 book-to-market- & size- & 20 beta-sorted portfolios	1963-2001	8.28 (3.12)	-0.84 (4.08)
Lewellen, Nagel and Shanken (2008) 25 book-to-market- & size-sorted portfolios	1963-2004	11.60 (3.65)	-1.76 (4.51)
Lewellen, Nagel and Shanken (2008) 25 book-to-market- & size-sorted & 20 industry portfolios	1963-2004	8.12 (3.16)	0.40 (4.44)
Panel B: Australian evidence			
CEG (2008) 10 beta-sorted portfolios	1974-2007	7.86 (2.67)	0.74 (3.74)
NERA (2013) 500 largest stocks	1963-2012	11.05 (3.39)	

Notes: Annualised estimates of the zero-beta premium and the empirical price of risk in per cent are produced by multiplying the monthly (quarterly) estimates provided by Table 3 of Fama and MacBeth, Tables 6 and 7 of Campbell and Vuolteenaho and Table 3 of CEG (Table 1 of Lewellen, Nagel and Shanken) by 12 (4). NERA annualise their estimates using a method that resembles the method that Brailsford, Handley and Maheswaran (2008) use to estimate the MRP and do not provide an estimate of the empirical price of risk. Standard errors are in parentheses.

Sources: Brailsford, T., J. Handley and K. Maheswaran, Re-examination of the historical equity risk premium in Australia, Accounting and Finance 48, 2008, pages 73-97.

Campbell, J. and T. Vuolteenaho, Bad beta, good beta, American Economic Review 94, pages 1249-1275.

CEG, Estimation of, and correction for, biases inherent in the Sharpe CAPM formula: A report for the Energy Networks Association, Grid Australia and APIA, 2008.

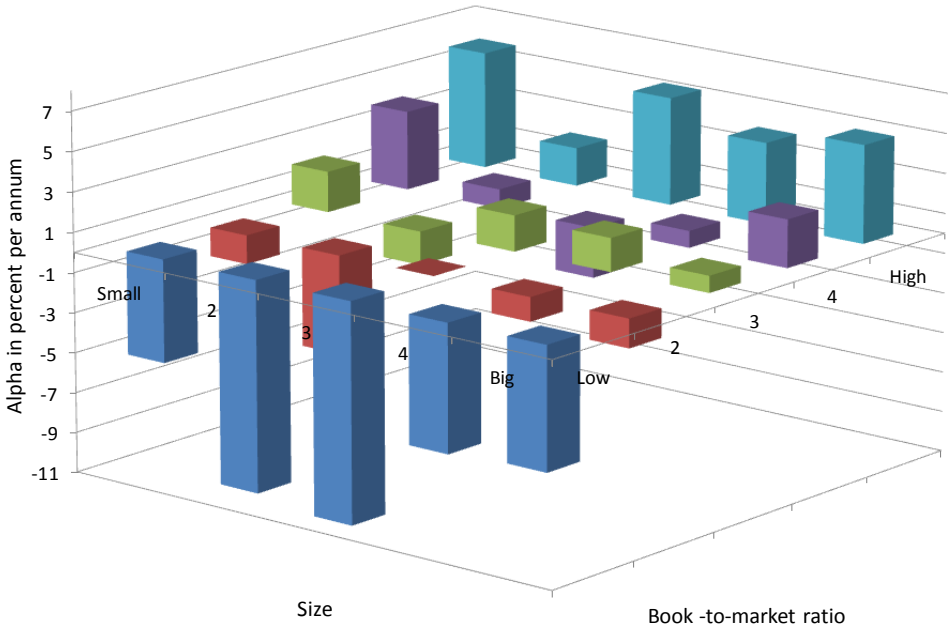
Fama, E and J. MacBeth, Risk, return, and equilibrium: Empirical tests, Journal of Political Economy 71, pages 607-636.

Lewellen, J., S. Nagel and J. Shanken, A skeptical appraisal of asset pricing tests, Journal of Financial Economics, 2010, pages 175-194.

NERA, Estimates of the zero-beta premium: A report for the Energy Networks Association, 2013.

[27] The zero-beta premium and price of risk are in percent per annum. Standard errors are in parentheses.

Figure 2.3
Plot of SL CAPM alpha against book-to-market and size: Australian data from 1982 to 2006



Source: Table 4 of Brailsford, Gaunt and O'Brien (2012).

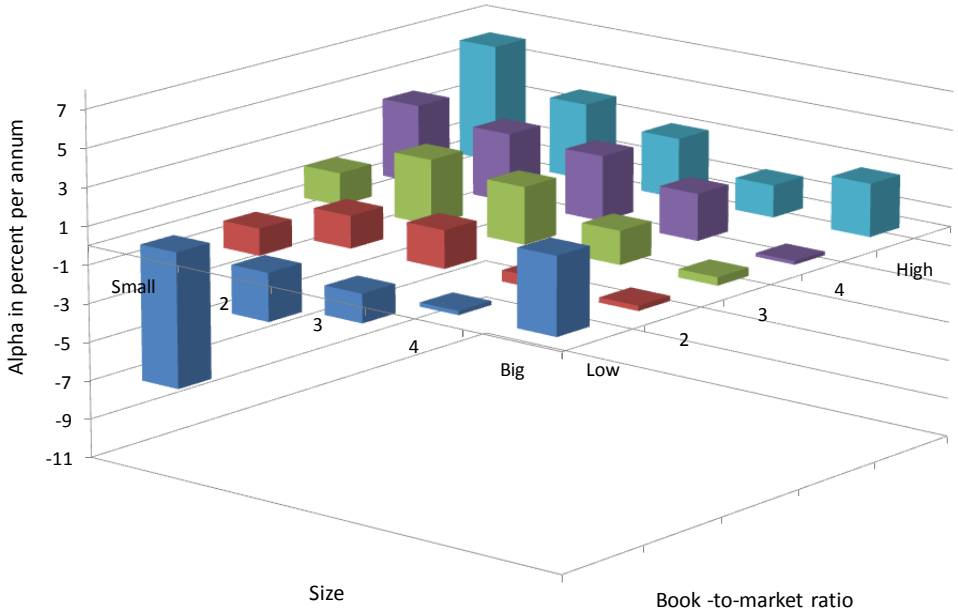
Brailsford, T., C. Gaunt and M. O'Brien, *Size and book-to-market factors in Australia, Australian Journal of Management, 2012, pages 261-281.*

A similar empirical regularity is observed in US data. Figure 2.4 below updates the evidence that Fama and French (1993) provide using US data from Ken French's web site.[28,29] The figure, like Figure 2.3, plots SL CAPM alphas against book-to-market and size for 25 portfolios formed on the basis of book-to-market and size. Figure 2.4 shows that US value stocks – that is, high book-to-market stocks – also have positive alphas. In other words, value stocks tend to earn higher returns than the SL CAPM predicts should be the case. Figure 2.4, in addition, shows that small value stocks have particularly large and positive alphas and small growth stocks have particularly large and negative alphas.

[28] Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

[29] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Figure 2.4
Plot of SL CAPM alpha against book-to-market and size: US data from 1927 to 2012



Notes: Data are from Ken French's web site. [30]

2.3. Discussion

An interesting question is why the empirical performance of the SL CAPM is so poor. There are two possible explanations:

- the model is wrong; and
- the model is right but the proxies typically employed for the market portfolio are poor.

Markowitz (2005) suggests that the assumptions that the SL CAPM makes are unrealistic and that the model is likely to be wrong.[31] Markowitz won the Nobel Prize in Economics in 1990 for his work in examining how investors might construct efficient portfolios. His work formed the basis for the work of Sharpe (1964) and Lintner (1965) in developing the SL CAPM. [32] For example, Markowitz states that: [33]

---

30 http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

31 Markowitz, H.M., *Market efficiency: A theoretical distinction and so what?* Financial Analysts Journal 61, 2005, pages 17-30.

32 Sharpe, William F., *Capital asset prices: A theory of market equilibrium under conditions of risk*, Journal of Finance 19, 1964, pages 425-442.

Lintner, John, *The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets*, Review of Economics and Statistics 47, 1965, pages 13-37.

> 'The assumption that the investor can borrow without limit is crucial to the Sharpe-Lintner model's conclusions. As illustrated later in this article, if we accept the other three CAPM assumptions but assume limited (or no) borrowing, the Sharpe-Lintner conclusions no longer follow.'
>
> '(If) we assume the first three premises of the Sharpe-Lintner CAPM but take into account the fact that investors have limited borrowing capacity, then it no longer follows that the market portfolio is efficient. As this article will illustrate, this inefficiency of the market portfolio could be substantial and it would not be arbitraged away even if some investors could borrow without limit.'
>
> '(T)he original CAPM, with unlimited borrowing ... (implies) that the expected return of a stock depends in a simple (linear) way on its beta, and only on its beta. This conclusion has been used for estimating expected returns, but it has lost favor for this use because of poor predictive results. It is still used routinely in "risk adjustment," however, for valuing assets and analyzing investment strategies on a "risk-adjusted basis." I will show here that the conclusion that expected returns are linear functions of beta does not hold when real-world limits on permitted portfolio holdings are introduced into the CAPM. This discussion will call into question the frequent use of beta in risk adjustment.'

Also, Markowitz makes clear that he believes that the problems associated with empirical versions of the SL CAPM would not disappear were one to be provided with a series of returns to the market portfolio of *all* assets. For example, Markowitz states that: [34]

> 'A frequent explanation of why observed expected returns do not appear to be linearly related to betas is that the measures of market return used in the tests do not measure the true, universal market portfolio that appears in the CAPM. The conclusion is that to test the CAPM, we need to measure returns on a cap-weighted world portfolio. The preceding discussion implies, how-ever, that before spending vast resources on ever finer approximations to returns on this cap-weighted universal portfolio, we should note that CAPM Conclusion 2 (that expected returns are linearly related to betas) is not likely to be true if real-world constraints are substituted for (the assumption that the SL CAPM makes of unlimited borrowing opportunities).'

Markowitz is similarly critical of the Black version of the CAPM. We will turn to what he has to say about that model in the next section.

It may well be that one will never be able to ascertain which of these competing explanations is correct. In other words, it may well be that one will never be able to ascertain whether the SL CAPM is true or false because of the difficulties that one encounters in measuring the return to the market portfolio. The issue of whether the model itself is correct, however, is essentially a purely academic question rather than a question of practical significance. The question that is of practical significance is whether the empirical version of the model on which the AER and other regulators have in the past relied is correct. The evidence that we provide indicates that the SL CAPM:

- is correct for stocks that have betas that are close to one, that are neither value nor growth stocks and that are not small-cap stocks; but

---

[33] Markowitz, H.M., *Market efficiency: A theoretical distinction and so what?* Financial Analysts Journal 61, 2005, pages 17-18.

[34] Markowitz, H.M., *Market efficiency: A theoretical distinction and so what?* Financial Analysts Journal 61, 2005, pages 28.

- is not correct for low-beta or high-beta stocks, value or growth stocks or small-cap stocks.

2.4. Assessment

The empirical evidence that we review suggests that the SL CAPM, while an attractively simple theory, does not explain satisfactorily the way the cost of equity is determined. President of the American Association Finance Association (2005) John Campbell and his co-author Tuomo Vuolteenah summarise the empirical evidence in the following way:[35]

> 'It is well known that the CAPM fails to describe average realized stock returns since the early 1960s, if a value-weighted equity index is used as a proxy for the market portfolio. In particular, small stocks and value stocks have delivered higher average returns than their betas can justify. Adding insult to injury, stocks with high past betas have had average returns no higher than stocks of the same size with low past betas.'

The empirical evidence suggests that the SL CAPM:

- will underestimate (overestimate) the return required on a low-beta (high-beta) stock;
- will underestimate (overestimate) the return required on a value (growth) stock; and
- may underestimate the return required on a small-cap stock.

Thus for a low-beta or value stock, the SL CAPM is likely to provide a downwardly *biased* estimate of the return that the market requires on the stock.

The SL CAPM, on the other hand, is likely to provide relatively *precise* estimates because it is such a restrictive model.[36]

---

[35] Campbell, J. and T. Vuolteenaho, *Bad beta, good beta*, American Economic Review 94, page 1249.

[36] The precision of an estimator of the return required on a stock that uses the model will depend on the precision with which one estimates beta and the precision with which one estimates the *MRP*. The precision of an estimator of the return required on a stock that uses the model will also depend on the stock's beta, the *MRP* and whether the model prices the stock correctly. All else constant, the precision of an estimator of the return required on a low-beta stock that uses the model will exceed the precision of an estimator of the return required on a high-beta stock that uses the model. This because the *MRP*, a parameter that one must estimate, plays a smaller role in determining the return required on a low-beta stock than on a high-beta stock. See

Wheatley, S.M., *Evaluating asset pricing models*, paper presented at the American Finance Association Meetings, Chicago, IL, 1998.

3. Black CAPM

While the SL CAPM is an attractively simple theory, it has been known for well over 40 years that empirical versions of the model tend to underestimate the returns to low-beta assets and overestimate the returns to high-beta assets. Mehrling (2005), for example, reports that:[37]

> 'The very first [Wells Fargo] conference was held in August 1969 at the University of Rochester in New York State ... The focus of the first Wells Fargo conference was on empirical tests of the CAPM ... the most significant output of the first conference was the paper of Fischer Black, Michael Jensen, and Myron Scholes (BJS), titled "The Capital Asset Pricing Model: Some Empirical Tests," eventually published in 1972. ... One important consequence of the BJS tests was to confirm earlier suggestions that low-beta stocks tend to have higher returns and high-beta stocks tend to have lower returns than the theory predicts.'

This empirical regularity prompted Black (1972), Vasicek (1971) and Brennan (1971) to examine whether relaxing the assumption that investors can borrow or lend freely at a single rate can produce a model that better fits the data.[38]

3.1. Theory

Brennan (1971) shows that if one replaces assumption (iv) of the SL CAPM with:[39]

(v) investors can borrow at a risk-free rate r_b and lend at a risk-free rate $r_l < r_b$, then:

$$\mathrm{E}(r_j) = \mathrm{E}(r_z) + \beta_j[\mathrm{E}(r_m) - \mathrm{E}(r_z)], \qquad r_l < \mathrm{E}(r_z) < r_b \tag{2}$$

where:

$\mathrm{E}(r_z)$ = the mean return to a zero-beta portfolio.

Although three authors contributed to the development of the model, the model is generally known as the 'Black CAPM'.

If $\mathrm{E}(r_z) = r_f$, the model collapses to the SL CAPM, illustrating the fact that the Black CAPM is a more general model than the SL CAPM. If $\mathrm{E}(r_z) > r_f$, as empirically is the case, as we note in section 2, then the SL CAPM will underestimate the mean returns to low-beta assets and overestimate the mean returns to high-beta assets. The Black CAPM, by construction, will neither underestimate the mean returns to low-beta assets nor overestimate the mean returns to high-beta assets.

---

37 Mehrling, Perry, *Fischer Black and the revolutionary idea of finance*, Wiley, 2005, pages 104-105.

38 Black, Fischer, *Capital market equilibrium with restricted borrowing*, Journal of Business 45, 1972, pages 444-454.

Brennan, Michael, *Capital market equilibrium with divergent borrowing and lending rates*, Journal of Financial and Quantitative Analysis 6, 1971, pages 1197-1205.

Vasicek, Oldrich, *Capital market equilibrium with no riskless borrowing*, Memorandum, Wells Fargo Bank, 1971.

39 Brennan, Michael, *Capital market equilibrium with divergent borrowing and lending rates*, Journal of Financial and Quantitative Analysis 6, 1971, pages 1197-1205.

It is important to recognise that the Black CAPM, like the SL CAPM, predicts that the market portfolio of *all* risky assets must be mean-variance efficient – it does not predict that the market portfolio of stocks must be mean-variance efficient.[40] The Black CAPM states that the risk of an asset should be measured relative to the market portfolio of all risky assets whereas empirical versions of the model measure the risk of an asset relative to a portfolio of stocks alone. It follows that one should *not* expect the zero-beta rate in an empirical version of the model to necessarily lie between the risk-free borrowing and lending rates. This is because the Black CAPM does not impose the restriction that the mean return to a portfolio that has a zero beta relative to the market portfolio of *stocks* must lie between the risk-free borrowing and lending rates.

3.2. Evidence

The evidence that we review in section 2 indicates that there is little relation between the return on a stock or portfolio and an estimate of its beta. For example, Figure 2.1 indicates that there is little relation between the return on a portfolio and an estimate of its beta for 10 Australian portfolios formed on past estimates of beta over the period 1974 to 2012. As a second example, Figure 2.2 indicates that there is little relation between the return on a portfolio and an estimate of its beta for 10 US portfolios formed on past estimates of beta over the period 1928 to 2003. Thus, the evidence that we review in section 2 indicates that empirical estimates of beta are not useful in pinning down the return required on stocks that have estimates of beta that differ from one.

The evidence that the relation between the return to a stock or portfolio and an estimate of its beta is flat does not imply that the return required on every stock must be the same. It does, however, imply that if one were to be constrained to using only an estimate of beta to measure risk, then the best that one could do would be to assume that the return required on every stock must be the same. In other words, it implies that the best that one could do would be to assume that the return required on every stock matches the return required on the market portfolio of stocks.

The Black CAPM predicts that the return required on every stock will be the same if the zero-beta premium matches the *MRP* – that is, if the mean return to a zero-beta portfolio matches the risk-free rate. It is not surprising, therefore that estimates of the zero-beta premium that we review in section 2 are similar in magnitude to estimates of the *MRP*. This result may appear implausible but it merely reflects the inability of estimates of beta to track variation in required returns across stocks.

The AER in its recent *Consultation Paper* states that it has not used the Black CAPM because:[41]

> 'we concluded that ... estimates of the zero–beta portfolio returns were highly variable and most likely unreliable.'

---

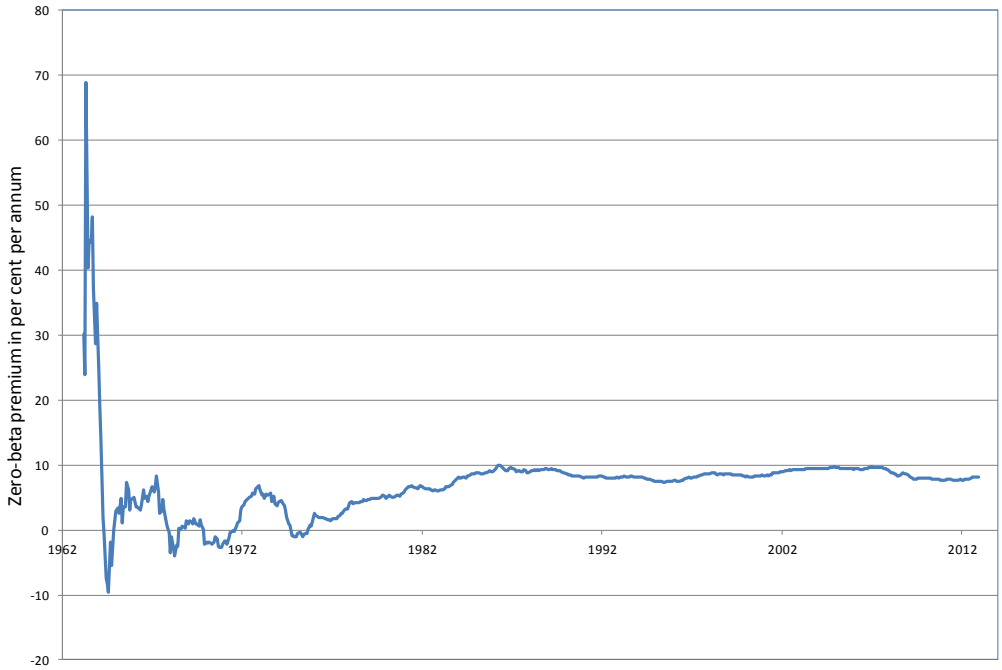
[40] Roll, Richard, *A critique of the asset pricing theory's tests: Part I*, Journal of Financial Economics 4, 1977, pages 129-176.

[41] AER, Consultation paper: Rate of return guidelines, May 2013, page 92.

NERA (2012, 2013) investigates whether estimates of the zero-beta premium are highly variable and finds evidence that estimates of the zero-beta premium are remarkably stable. Figure 3.1 below is from NERA (2013).[42] The figure plots recursive estimates of the zero-beta premium against time. The *k*th recursive estimate uses the first *k* observations to form an estimate of the zero-beta premium. So as *k* increases, the size of the sample used to estimate the premium grows.

Figure 3.1 plots recursive estimates of the zero-beta premium computed using the largest 100 Australian stocks from 1963 to 1973 and the largest 500 stocks from 1974 to 2012. Estimates of the premium that are based on relatively few months of data will be imprecise while estimates based on a relatively large number of months are likely to be more precise – at least so long as the premium does not vary substantially through time. The figure shows this to be case. Estimates that use less than 20 years of data – those estimates made before 1983 – vary considerably through time while estimates that use at least 20 years of data – those estimates made after 1982 – vary little.

Figure 3.1
Recursive estimates of the zero-beta premium



Notes: Data are from the RBA and SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Estimates are computed using data from 1958 to 2012.

Source: NERA, Estimates of the zero-beta premium: A report for the Energy Networks Association, 2013.

Besides evidence that indicates that there is little relation between the return to a stock or portfolio and an estimate of its beta, there is also evidence that variables other than beta are useful for tracking variation in return across stocks – contrary to the prediction of the Black

[42] NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, 2013.

CAPM that there be a linear relation between beta and return. Fama and French (1992), for example, show that, conditional on beta, there is a positive relation between return and book-to-market and a negative relation between return and market capitalisation but that, conditional on book-to-market and market capitalisation, there is no evidence of a relation between return and beta.[43]

3.3. Discussion

As with the SL CAPM, there are two possible explanations for why the performance of an empirical version of the Black CAPM appears to be so poor:

- the model is wrong; and
- the model is right but the proxies typically employed for the market portfolio are poor.

Markowitz (2005) suggests that the assumptions that the Black CAPM – what he labels an alternate version of the CAPM – makes are unrealistic and that the model is likely to be wrong.[44] For example, Markowitz states that:[45]

> 'An alternate version of the CAPM speaks of investors holding short as well as long positions. But the portfolios this alternate CAPM permits are as unrealistic as those of the Sharpe-Lintner C APM with unlimited borrowing.'

> '(T)he alternate CAPM, with unrealistic short rules, (implies) that the expected return of a stock depends in a simple (linear) way on its beta, and only on its beta. This conclusion has been used for estimating expected returns, but it has lost favor for this use because of poor predictive results. It is still used routinely in "risk adjustment," however, for valuing assets and analyzing investment strategies on a "risk-adjusted basis." I will show here that the conclusion that expected returns are linear functions of beta does not hold when real-world limits on permitted portfolio holdings are introduced into the CAPM. This discussion will call into question the frequent use of beta in risk adjustment.'

Markowitz also makes clear that he believes that the problems associated with empirical versions of the Black CAPM would not disappear were one to be provided with a series of returns to the market portfolio of *all* assets. Thus Markowitz believes that the assumptions that both the SL CAPM and Black CAPM make are unrealistic and that replacing these assumptions by more realistic assumptions would remove the implication of both models that there should be a positive linear relation between risk, measured by beta, and return.

Several references have been made by the AER and its advisors to the work of Roll. The argument that appears to have been made is that because:

- one cannot observe the return to the market portfolio of all assets; and because

---

[43] Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

[44] Markowitz, H.M., *Market efficiency: A theoretical distinction and so what?* Financial Analysts Journal 61, 2005, pages 17-30.

[45] Markowitz, H.M., *Market efficiency: A theoretical distinction and so what?* Financial Analysts Journal 61, 2005, page 18.

- the results of tests of the CAPM can be sensitive to the choice of a proxy for the market portfolio of all assets,

one can dismiss what is widely regarded as evidence against an empirical version of the model and use the model – or at least an empirical version of the model – anyway. For example, the AER states in its 2011 Envestra final decision that:[46]

> 'The seminal 1977 paper by Roll supports the position that the 'low beta bias' empirical finding results from a problem with the test (a mis-specified market portfolio) not a problem with the underlying CAPM.'

As another example, in its *Consultation Paper*, the AER states that:[47]

> 'Empirical findings of a low–beta bias in the Sharpe–Lintner CAPM, for example, plausibly arose from flaws in testing methods (rather than any deficiencies in the model itself). These flaws included relying on invalid proxies.
>
> We have used the Sharpe–Lintner CAPM to determine the return on equity in each of our access arrangements and determinations to date.'

It is important to note that this view is most definitely not shared by Roll. Roll and Ross (1994), for example, state about the evidence that Fama and French (1992) provide that there is little relation between the return to a stock and an estimate of its beta that:[48]

> 'An alternative interpretation of their results is that the SLB Model may be of little use in explaining cross-sectional returns no matter how close the index is to the efficient frontier unless it is exactly on the frontier. Since such exactitude can never be verified empirically, we would endorse (again, as we have in the past when we first asserted the proposition; see, e.g., Roll (1977), and Chen, Roll, and Ross (1986)), that the SLB is of little practical use in explaining stock returns.'

In other words, far from suggesting that one use the CAPM anyway, Roll and Ross suggest that one abandon its use.

3.4. Assessment

The empirical evidence suggests that an empirical version of the Black CAPM:

- will underestimate (overestimate) the return required on a value (growth) stock; and
- may underestimate (overestimate) the return required on a small-cap (large-cap) stock.

---

[46] AER, *Final decision Envestra Ltd: Access arrangement proposal for the SA gas network 1 July 2011 – 30 June 2016*, June 2011, page 169.

[47] AER, Consultation paper: Rate of return guidelines, May 2013, pages 90-91.

[48] SLB stands for Sharpe-Lintner-Black.

Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

Roll, R. and S. Ross, *On the cross-sectional relation between expected returns and betas*, Journal of Finance, 1994, page 111.

The Black CAPM will, on the other hand, eliminate the tendency of an empirical version of the SL CAPM to underestimate (overestimate) the returns required on low-beta (high-beta) stocks. Again, when we refer to an empirical version of the SL CAPM, we refer to a version that uses a value-weighted portfolio of stocks as a proxy for the market portfolio. This is the version that the AER uses and it is the version that almost all academic tests of the model employ.[49]

Thus the Black CAPM is likely to provide a downwardly *biased* estimate of the return that the market requires on a value stock. On the other hand, the Black CAPM is likely to provide an unbiased estimate of the return required on a stock that is neither a value nor a growth stock.

The Black CAPM, though, because it is a more general model than the SL CAPM, will produce less *precise* estimates than the SL CAPM.

[49] Stambaugh (1982) conducts tests that do not rely on a value-weighted portfolio of stocks as a proxy for the market portfolio. He rejects the SL CAPM in favour of the Black CAPM. We discuss his work in the next section.

Stambaugh, R., *On the exclusion of assets from tests of the two-parameter model: A sensitivity analysis*, Journal of Financial Economics 10, 1982, pages 237-268.

4. Fama-French three-factor model

Fama and French (1992) show that, contrary to the predictions of both the SL CAPM and Black CAPM, the market value of a firm's equity and the ratio of the book value of the equity to its market value are better predictors of the equity's return than is the equity's beta.[50,51] If there are factors besides the return to the market portfolio of stocks that are pervasive, then the Arbitrage Pricing Theory (APT) of Ross (1976) predicts that the additional risks associated with the factors should be priced.[52]

The intuition behind the APT is that investors will be rewarded for risks that are pervasive and they cannot diversify away but will not be rewarded for risks that are idiosyncratic and that they can diversify away. If investors were not rewarded for bearing pervasive risks, arbitrage opportunities would arise. Thus Fama and French (1993) argue that if assets are priced rationally, then variables that can explain the cross-section of mean returns must be proxies for risks that cannot be diversified away.[53]

4.1. Theory

Fama and French (1993) suggest that there are three pervasive sources of risk or factors:[54]

(i) the excess return to the market portfolio;

(ii) the difference between the return to a portfolio of high book-to-market stocks and the return to a portfolio of low book-to-market stocks (*HML*); and

(iii) the difference between the return to a portfolio of small-cap stocks and the return to a portfolio of large-cap stocks (*SMB*).

If these three factors are the only pervasive sources of risk and a risk-free asset exists, then, to avoid arbitrage opportunities, it must be true that:

---

50 Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

51 Kothari, Shanken, and Sloan (1995) suggest that the evidence that Fama and French provide may reflect survivorship bias. In particular, they suggest that selective backfilling by Compustat may provide the appearance of a stronger value effect than actually exists. Chan, Jegadeesh and Lakonishok (1995), however, show that selection bias contributes negligibly to the value effect in Compustat data and Davis (1994) shows that a value effect exists in pre-Compustat data that are free from any survivorship bias.

Chan, Louis K. C., Narasimhan Jegadeesh, and Josef Lakonishok, *Evaluating the performance of value versus glamour stocks: The impact of selection bias*, Journal of Financial Economics, 1995, pages 269–296.

Davis, James L., *The cross-section of realized stock returns: The pre-Compustat evidence*, Journal of Finance, 1994, pages 1579–1593.

Kothari, S.P., Jay Shanken, and Richard G. Sloan, *Another look at the cross-section of expected stock returns*, Journal of Finance, 1995, pages 185–224.

52 Ross, Stephen, *The arbitrage theory of capital asset pricing*, Journal of Economic Theory 13, pages 341-360.

53 Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

54 Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

$$\mathrm{E}(r_j) = r_f + b_j[\mathrm{E}(r_m) - r_f] + h_j \mathrm{E}(HML) + s_j \mathrm{E}(SMB), \quad (3)$$

where:

b_j, h_j and s_j are the slope coefficients from a multivariate regression of r_j on r_m, *HML* and *SMB*, and E(*HML*) and E(*SMB*) are the *HML* and *SMB* premiums.

The R^2 values attached to the time series regressions of the returns to the 25 US portfolios on the three factors that Fama and French (1993) report range from 0.83 to 0.97.[55] R^2, known as the coefficient of determination, represents the fraction of the variation in a dependent variable explained by variation in a set of independent variables. Thus a regression that has an R^2 that is close to one is a regression in which the set of independent variables comes close to fully explaining variation in the dependent variable. It follows that the high R^2 values that Fama and French report indicate that one could almost replicate the returns to the 25 portfolios using the three Fama-French factors. Thus, as Cochrane (2001) points out, the three-factor model must be approximately true to avoid near arbitrage opportunities. He states that:[56]

> 'given the average returns and the failure of the CAPM to explain those returns, there would be near-arbitrage opportunities if value and small stocks did not move together in the way described by the Fama-French model.'

If the R^2 values were all equal to 1.00, the three-factor model would have to hold *exactly* to rule out arbitrage opportunities. The idea that prices should be set so as to rule out arbitrage opportunities is one of the most basic and oldest in Finance. Rubinstein notes that Fisher used a no-arbitrage argument as early as 1907.[57]

Whereas the SL CAPM and Black CAPM underestimate the returns to small-cap stocks and value stocks, the Fama-French model is designed to explain the returns to small-cap stocks and value stocks correctly.

4.2. Evidence

Figure 4.1 below summarises evidence that Brailsford, Gaunt and O'Brien (2012) provide using Australian data.[58] The figure plots Fama-French alphas against book-to-market and size for 25 Australian portfolios formed on the basis of book-to-market and size. Again, an asset's alpha is a measure of the error with which a model prices the asset. It is the difference between the mean return to the asset and the return that the model predicts that the asset should on average earn. If an asset has a positive alpha, the model underestimates the return that the market requires the asset earn. If an asset has a negative alpha, the model overestimates the return that the market requires on the asset.

---

55 Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

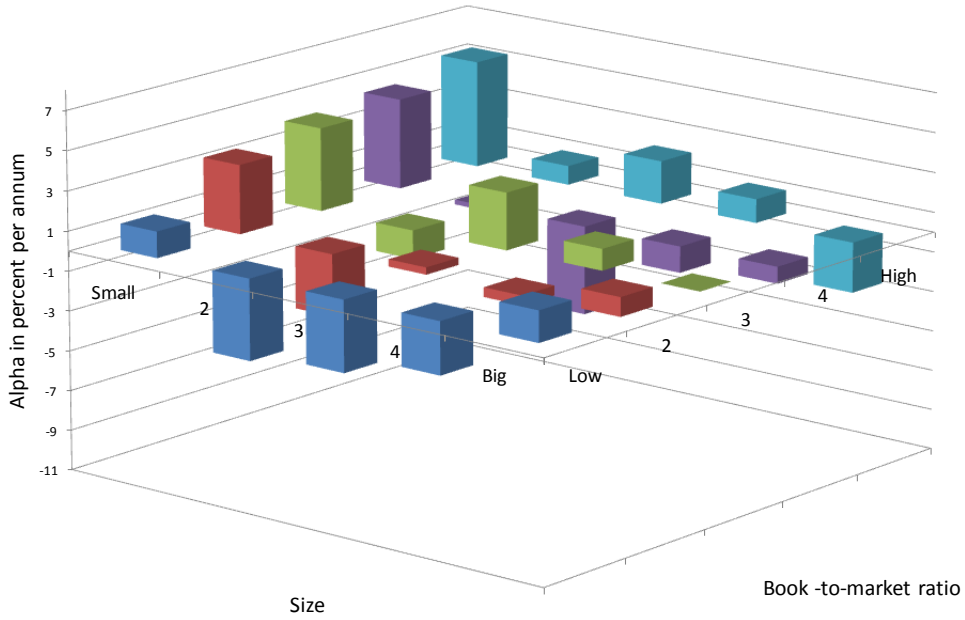
56 Cochrane, John H., *Asset pricing*, Princeton University Press, 2001, page 442.

57 Rubinstein, M., *A history of the theory of investments*, Wiley, 2006, page 7.

58 Brailsford, T., C. Gaunt and M. O'Brien, *Size and book-to-market factors in Australia*, Australian Journal of Management, 2012, pages 261-281.

Figure 4.1 shows that value and growth stocks have much smaller Fama-French alphas than they have SL CAPM alphas. Thus the evidence that Brailsford, Gaunt and O'Brien (2012) provide indicates that the Fama-French three-factor model does a better job of describing the data. Tests that Brailsford, Gaunt and O'Brien conduct of the hypothesis that the Fama-French alphas attached to the 25 portfolios are simultaneously zero do not reject the null at conventional significance levels. In contrast, they find that a test of the hypothesis that the SL CAPM alphas attached to the 25 portfolios are simultaneously zero rejects the null.

Figure 4.1
Plot of Fama-French three-factor model alpha against book-to-market and size: Australian data from 1982 to 2006



Source: Table 4 of Brailsford, Gaunt and O'Brien (2012).

Brailsford, T., C. Gaunt and M. O'Brien, Size and book-to-market factors in Australia, Australian Journal of Management, 2012, pages 261-281.

Figure 4.2 updates the evidence that Fama and French (1993) provide using US data from Ken French's web site.[59] The figure, like Figure 4.1, plots Fama-French alphas against book-to-market and size for 25 portfolios formed on the basis of book-to-market and size. Figure 4.2 shows, again like Figure 4.1, that value and growth stocks typically have much smaller Fama-French alphas than they have SL CAPM alphas. [60]

---

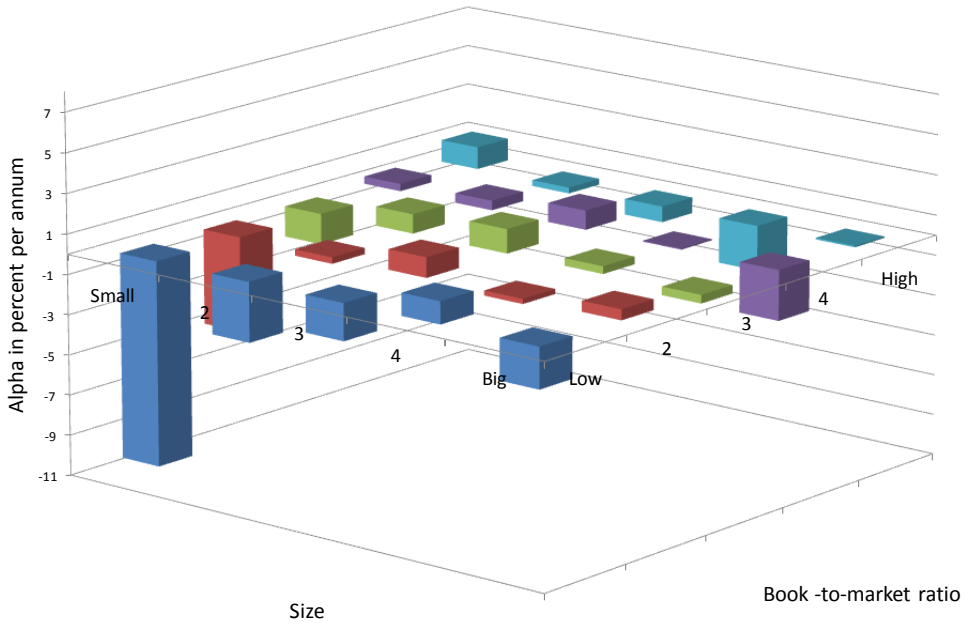
[59] Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

[60] Small growth stocks are an exception. Figure 4.2 indicates that they have large and negative alphas. Larry Swedroe of CBS News reports that DFA, with whom Fama and French are affiliated, screen out these stocks from some of the portfolios that they manage. See:

http://www.cbsnews.com/8301-505123_162-37841482/the-black-hole-of-investing/

Despite the widespread acceptance of the Fama-French model by the academic community, though, recent evidence indicates that the Fama-French model, like the SL CAPM, underestimates (overestimates) the returns to low-market-beta (high-market-beta) stocks. Lajbcygier and Wheatley (2009) provide an Australian estimate of the zero-beta premium for the Fama-French three factor model of 9.00 per cent per annum that differs significantly from zero at conventional levels while Lewellen, Nagel and Shanken (2010) report US estimates of the zero-beta premium for the Fama-French three factor model of 8.84 and 11.96 per cent per annum that also differ significantly from zero at conventional levels. [61]

Figure 4.2
Plot of Fama-French three-factor model alpha against book-to-market and size: US data from 1927 to 2012



Notes: Data are from Ken French's web site. [62]

4.3. Discussion

Several authors have suggested that the value premium is the result of either data mining or problems with the data that Fama and French (1992) use.[63] For example, Black (1993) states that:[64]

---

[61] Lajbcygier and Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, 2009.

Lewellen, J., S. Nagel and J. Shanken, *A skeptical appraisal of asset pricing tests*, Journal of Financial Economics, 2010, pages 175-194.

[62] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[63] Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

[64] Black, F., Beta and return, Journal of Portfolio Management, 1993, page 76.

> 'I think that it is quite possible that even the book-to-market effect results from data mining.'

As another example, Kothari, Shanken, and Sloan (1995) suggest that the evidence that Fama and French provide may reflect survivorship bias.[65] In particular, they suggest that selective backfilling by Compustat may provide the appearance of a stronger value effect than actually exists.

Davis (1994) provides evidence of a value premium in pre-Compustat data that are free from any survivorship bias and that are taken from a period that precedes the period that Fama and French (1992) examine.[66] This suggests that the value premium does not result from data mining or survivorship bias. In addition, Chan, Jegadeesh and Lakonishok (1995) show that selection bias contributes negligibly to the value effect in Compustat data.[67] This suggests that the value premium is not the result of problems with the data that Fama and French (1992) use.[68]

The AER has also suggested that there is not uniform agreement on how to measure an Australian *HML* factor and that different measures produce different estimates of the *HML* premium.[69] For example, the AER in its *Consultation Paper* states that:[70]

> 'There was no strong theoretical basis to support the inclusion of the additional Fama–French three factor model risk factors for the rate of return on equity. For example, the model was dependent on empirical justification—that is, the systematic observance of the three factor risk premiums. Since these risk premiums were not systematically observed in the Australian market, there was no reasonable basis for the Fama–French three factor model to be applied in Australia ...
>
> analysis from Australia showed that observed empirical evidence was not consistent with the Fama–French three factor model—notably conflicting and variable risk premiums, and inconsistent factor coefficients.'

The tendency of different measures to produce different estimates of the *HML* premium can be attributed to the different ways in which various data providers produce value and growth portfolios. Fama and French, for example, exclude the 40 per cent of stocks that are not distinctly value or growth from their value and growth portfolios. MSCI and Standard and Poors (S&P), in contrast, do not exclude these or indeed any stocks. If there is a value premium – and the evidence that we review is consistent with the hypothesis that there is a value premium – then it should show up more clearly when we compare the returns to

---

65 Kothari, S.P., Jay Shanken, and Richard G. Sloan, *Another look at the cross-section of expected stock returns*, Journal of Finance, 1995, pages 185–224.

66 Davis, James L., *The cross-section of realized stock returns: The pre-Compustat evidence*, Journal of Finance, 1994, pages 1579–1593.

Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

67 Chan, Louis K. C., Narasimhan Jegadeesh, and Josef Lakonishok, *Evaluating the performance of value versus glamour stocks: The impact of selection bias*, Journal of Financial Economics, 1995, pages 269–296.

68 Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

69 We also address the AER's view in:

NERA, *Market, size and value premiums: A report for the Energy Networks Association*, 2013.

70 AER, Consultation paper: Rate of return guidelines, May 2013, page 96.

portfolios that exhibit strong value and growth characteristics than when we compare the returns to portfolios that have only weak value and growth characteristics. Consistent with this idea, the *HML* premium computed from the data that Fama and French supply is larger than the *HML* premium computed from the data that MSCI and S&P supply.

Issues about how to construct the data are by no means limited to the Fama-French model. To illustrate how ambiguity about how to measure the return to the market portfolio can create substantial variation across estimates of the mean return to the market portfolio, we use data from Stambaugh (1982).[71] Table 4.1 provides estimates of the mean real return to the US market portfolio in per cent per annum across four different time periods using the four measures of the market that Stambaugh employs. As the table makes clear, the estimates are sensitive to the way the market proxy is constructed. Nevertheless, Stambaugh finds that tests of the SL CAPM and Black CAPM are not sensitive to the use of a proxy. His tests reject the SL CAPM but find little evidence against the Black CAPM.

Table 4.1
Estimates of the mean real return to the market portfolio: US evidence from 1953 to 1976

	Market proxy			
Period	1	2	3	4
1953-1959	15.74	7.25	2.75	0.98
1959-1965	9.95	6.85	3.12	1.39
1965-1971	1.87	0.38	-0.02	-0.64
1971-1976	0.50	0.43	-0.11	-0.14
1953-1976	7.02	3.73	1.43	0.40

Note: Market proxy no. 1 is a value-weighted portfolio of NYSE common stocks; market proxy no. 2 is no. 1 plus corporate bonds and government bonds and Treasury bills; market proxy no. 3 is no. 2 plus real estate, house furnishings and automobiles; market proxy no 4 is the same as no. 3 but with NYSE stocks given a 10 per cent weight. All returns are in per cent per annum.

Source: Stambaugh, R., On the exclusion of assets from tests of the two-parameter model: A sensitivity analysis, Journal of Financial Economics 10, 1982, pages 237-268.

4.4. Assessment

The empirical evidence that Lajbcygier and Wheatley (2009) and Lewellen, Nagel and Shanken (2010) provide indicates that the Fama-French three-factor model will underestimate (overestimate) the return required on a low-market-beta (high-market-beta) stock.[72] The

[71] Stambaugh, R., *On the exclusion of assets from tests of the two-parameter model: A sensitivity analysis*, Journal of Financial Economics 10, 1982, pages 237-268.

[72] Lajbcygier and Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, 2009.

Lewellen, J., S. Nagel and J. Shanken, *A skeptical appraisal of asset pricing tests*, Journal of Financial Economics, 2010, pages 175-194.

Fama-French model will, on the other hand, eliminate the tendency of the SL CAPM to underestimate (overestimate) the returns required on value and small-cap (growth and large-cap) stocks.

Thus the Fama-French model is likely to provide a downwardly *biased* estimate of the return that the market requires on a low-market-beta stock. On the other hand, the Fama-French model is likely to provide an *unbiased* estimate of the return required on a stock that has a market beta of one and that is a value, growth, small-cap or large-cap stock.

The Fama-French model, though, because it contains more parameters than the SL CAPM, will produce less *precise* estimates than the SL CAPM.

5. Dividend Growth Models

The dividend growth model (DGM) is based on the idea that the price of a stock or a portfolio must equal the present value of the expected stream of dividends it will pay in the future. As Easton, Taylor, Shroff and Sougiannis (2002) and Berk and deMarzo (2007) point out, the DGM is thus based on the principle that there should be no arbitrage opportunities in an efficient capital market. [73] The DGM plays a central role in the financial analysis and regulation of US utilities.

5.1. Theory

The DGM allows one to use market prices together with forecasts of future dividends to compute the return that the market requires on an asset or portfolio. That is, the use of the DGM allows one to determine the discount rate that equates expectations of future payments to the owners of equity (ie, dividend payments) with the current price of the asset or portfolio. Thus, in principle, the DGM can deliver for a stock or portfolio a direct estimate of investors' forward looking required return.[74]

There are a number of different versions of the DGM. Two widely used versions are:

- the constant growth model; and
- a multi-stage growth model.

5.1.1. Constant growth DGM

The simplest form of DGM is a single constant growth model that is expressed as: [75]

$$P = \frac{D}{k - g} \tag{4}$$

where:

P = the current price of the stock;

---

[73] Berk, J. and P. deMarzo, Corporate finance, Pearson Addison-Wesley, 2007, pages 246-256.

Easton, P., G. Taylor, P. Shroff and T. Sougiannis, *Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment*, Journal of Accounting Research 40, 2002, page 660.

See also:

Rubinstein, M., *The valuation of uncertain income streams and the pricing of options*. Bell Journal of Economics, 1976, pages 407-25.

[74] In practice, an estimate of the long-run growth in dividends is often based on historical data. Easton, Taylor, Shroff and Sougiannis (2002), however, provide a method that uses the DGM and a cross-section of stocks to estimate the long-run growth in dividends and so they show that it is not necessary to rely on historical data.

Easton, P., G. Taylor, P. Shroff and T. Sougiannis, *Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment*, Journal of Accounting Research 40, 2002, page 660.

[75] See Berk, J. and P. deMarzo, Corporate finance, Pearson Addison-Wesley, 2007, page 249.

D	=	a forecast of the next dividend;
k	=	the (assumed constant) discount rate applied to equity; and
g	=	the perpetual growth rate of dividends.

Rearranging this equation to estimate the discount rate for equity:

$$k = \frac{D}{P} + g \tag{5}$$

In other words, under the DGM the required return on equity of an asset is the sum of:

- the forecast dividend yield; plus
- the expected growth rate in future dividends.

In the US, regulators generally estimate g as the sum of expected growth from future retained earnings ('*br*' growth) and expected future growth from the sale of common stock above book value ('*sv*' growth).[76]

The growth from future retained earnings is the product of the expected retention rate '*b*' and the expected return on common equity '*r*'. The expected retention rate is calculated from forecasts of earnings per share and dividends per share (ie, $b = 1 - DPS / EPS$). The value of '*r*' is taken from surveys of investment analysts.[77]

Growth from the sale of common stock is the product of the percent of common equity expected to be issued annually as new common stock '*s*' and the equity accretion ratio '*v*'. The equity accretion ratio is normally calculated using the following formula:

$$v = \left(1 - \frac{BookValue}{MarketValue}\right), \tag{6}$$

where:

Book Value	=	the book value of net assets owned by the firm;
Market Value	=	the market value of the outstanding shares.

The Federal Energy Regulatory Commission (FERC) employs this constant growth DGM to estimate the cost of equity for electricity utilities.[78]

---

[76] Southern California Edison Company, 92 FERC¶61,070, 26 July 2000, pages 20-21; and SoCal in note 37 refers to *Connecticut Light and Power Co*., 45 FERC¶61,370 at 62,161, n 15. (1988).

[77] Given the depth of the investment analyst market in the US, these published forecasts of expected earnings are generally accepted as unbiased.

[78] See FERC Order 420, 1985, Federal Register Vol. 50 No. 103.

Few companies satisfy the constant growth assumption. Also, analysts typically forecast dividend growth out to no more than five years. Relying on forecasts of near-term dividend growth, though, runs the risk that one will either overestimate or underestimate the return required on the stock or portfolio depending on whether near-term growth is above or below its long-run mean.

5.1.2. Multi-stage growth model

A constant growth DGM assumes that the growth rate *g* that is currently observed will continue indefinitely. In contrast, a multi-stage DGM does not assume that the prevailing growth rate will continue indefinitely and so combines short-term estimates of dividend growth with estimates of the long-term dividend growth rate.[79]

An example of a multi-stage DGM is one that assumes that the growth rate reverts to its long-term average. Bloomberg employs such an approach to produce estimates of the *MRP* for a number of countries, including Australia. Officer and Bishop describe the way in which Bloomberg constructs these estimates as follows:[80]

> 'Bloomberg works with individual stocks in each country's equity index. They use a three stage growth approach generally transitioning over 14 years from a 3 year near term growth rate to a long term or maturity growth rate. The internal rate of return is derived from solving for the discount rate that equates the present value of the dividend forecasts with the current share price. These internal rates of return are market capitalisation weighted to generate an overall market rate of return. The current yield on 10 year Treasury Bonds is deducted from this to determine a market risk premium.'

Another example of a multi-stage DGM is that applied by the FERC to determine the cost of equity for gas and oil pipelines. The FERC determines the growth rate by:[81]

- gathering analysts' five-year forecasts for each company in the proxy group, as published by Institutional Brokers' Estimate System (IBES), to determine growth for the short term;
- setting long-term growth equal to forecasts of long-term growth of the economy as a whole, that is, long-term growth in gross domestic product;[82] and
- calculating a single growth rate for DGM that places a weight of two thirds on short-term forecasts and one third on long-term forecasts.

---

79 Damodaran, A., Investment valuation, Wiley, 2012, Chapter 10.

80 Officer, R. and S. Bishop, *Market risk premium: A Review paper, Prepared for Energy Networks Association, Australian Pipeline Industry Association and Grid Australia*, Value Adviser Associates, August 2008, page 14.

81 FERC, *Composition of Proxy Groups for Determining Gas and Oil Pipeline Return on Equity - Policy Statement*, 17 April 2008, page 3.

82 Note that for Master Limited Partnerships (MLP) the long-term growth rate is assumed to be 50 per cent of long-term forecast GDP growth. See FERC, *Composition of Proxy Groups for Determining Gas and Oil Pipeline Return on Equity - Policy Statement*, 17 April 2008 page 41.

5.2. Evidence

DGM analysis plays a central role in determining the cost of equity for regulated utilities in the United States of America. The practice of determining a 'fair return' is guided by the landmark Supreme Court decisions in *Hope* and *Bluefield*. These decisions establish that a fair return must be a return sufficient to attract capital and must compensate investors at a level consistent with the returns provided by investments of comparable risk. In *Bluefield*, the Supreme Court held:[83]

> 'A public utility is entitled to such rates as will permit it to earn a return on the value of the property which it employs for the convenience of the public equal to that generally being made at the same time and in the same general part of the country on investments in other business undertakings which are attended by corresponding risks and uncertainties, but it has no constitutional right to profits such as are realized or anticipated in highly profitable enterprises or speculative ventures.'

In *Hope*, the court found:[84]

> '…the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and attract capital. '

Federal and state regulators in the US who are charged with implementing the standards set forth in *Bluefield* and *Hope* predominantly use the DGM to determine a fair return. Regulators that rely on the DGM to set the cost of equity include:

- FERC, which uses a single-stage DGM for electric utilities[85] and a multi-stage DGM for gas and oil pipelines;[86]
- the New York Public Service Commission, which used the DGM when setting power prices for the Niagara Mohawk power utility company;[87]
- the California Public Utilities Commission, which uses a range of models including the DGM to establish a fair return on equity;[88]
- the Florida Public Service Commission, which uses the DGM to estimate the cost of equity;[89] and

---

83 *Bluefield Water Works & Improvement Co. v. Public Service Commission of West Virginia* (262 U.S. 679, 692-3, 1923).

84 *Federal Power Commission v. Hope Natural Gas Company*, 320 U.S. 591 (1944).

85 See FERC Order 420, 1985, Federal Register Vol. 50 No. 103.

86 FERC, *Composition of Proxy Groups for Determining Gas and Oil Pipeline Return on Equity - Policy Statement*, 17 April 2008.

87 See Regulatory Research Associates, New York Rate Case, Final Report, February 10, 2011.

88 See California Public Utilities Commission, Interim Opinion on Rates of Return on Equity for Test Year 2003, D0211027.

89 See Regulatory Research Associates, Florida Rate Case, Final Report, April 13, 2012.

- the Texas Public Utility Commission, which identifies the use of the DGM as an appropriate method for estimating the cost of equity.[90]

A feature of US regulatory decisions is the stability of the cost of equity chosen over time. Table 5.1 below provides data on decisions by US regulators, for which data are readily available, in relation to the allowed return on equity for the period from 1998 through to the first quarter of 2012, for electricity and gas utilities respectively.[91]

The information presented in Table 5.1 shows that the average cost of equity has remained within a relatively narrow range over the 14-year period for which observations are readily available – between 10.22 and 11.66 per cent for electricity and between 9.63 and 11.51 per cent for gas utilities. These costs of equity are predominantly determined using the DGM.

5.3. Discussion

The stability of US regulatory decisions on the cost of equity over time is not surprising. These decisions are predominantly based on a use of the DGM and the DGM delivers the single internal rate of return that will discount the dividends that a stock or portfolio is expected to deliver back to the current market value of the stock or portfolio. This internal rate of return will be a complicated average of the costs of equity over the next year and over all future years. In other words, the internal rate of return is a complicated average of the discount rate that one should use to evaluate a payment to be made in one year's time, the discount rate that one should use to evaluate a payment to be made in two years' time, and so on. It follows that an estimate of the cost of equity derived using the DGM will tend to lie below the short-term cost of equity when the short-term cost of equity lies above its long-run mean and above the short-term cost of equity when the short-term cost of equity lies below its long-run mean. Consequently, estimates of the cost of equity that are generated by the DGM are likely to be less volatile than alternative estimates.

For this reason, Lally (2013) argues that estimates of the cost of equity generated by the DGM can provide biased estimates of the currently prevailing return.[92] While this argument is correct, we note that the bias should not be systematic over time. In other words, estimates of the cost of equity generated by the DGM should on average be unbiased.[93] It is also unclear how large the bias to which Lally alludes should be. In his 2013 report Lally provides only hypothetical examples to illustrate how a bias might arise.

Table 5.1 suggests that DGM estimates of the cost of equity for a US regulated energy utility are relatively precise. Again, we define the precision of a random variable here, as in the

---

90 See Regulatory Research Associates, Texas Rate Case, Final Report, November 21, 2012 and Texas Railroad Commission, *Rate Handbook 2012*.

91 Regulatory Research Associates, *Regulatory Focus Major Rate Case Decisions – January-March 2012*, 5 April 2012, as obtained from the New York Power Authority website. See: http://www.nypa.gov/TransmissionFiling/Exhibit%20PA-11%20-%20RRA%20Major%20Rate%20Case%20Decisions.pdf, accessed 7 November 2012.

92 Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013.

93 So long as there is no bias that might arise from, for example, a choice of an estimate of long-run dividend growth.

statistics literature, to be the reciprocal of its variance.[94] The AER, on the other hand, highlights in its *Consultation Paper* its concerns with the use of DGM estimates of the cost of equity for an Australian regulated energy utility. The AER states that: [95]

> 'We have not used dividend growth model estimates to determine the return on equity in any regulatory decision to date. Instead, previous decisions considered that dividend growth model estimates were highly contentious and could not be estimated with precision for Australian markets. This reflected concerns with determining robust input parameter estimates from limited data sets. These small data sets were contrasted with the much larger sample of data available in the US, where dividend growth model estimates are used more extensively.'

The evidence that SFG provide, however, suggests that DGM estimates of the cost of equity for an Australian regulated energy utility are, like their US counterparts, relatively precise. Their Table 4 is reproduced as Table 5.2 below and shows that DGM estimates of the cost of equity display remarkably little variation through time.

We also note that the variability of DGM estimates depicted in Table E-1 of the AER *Consultation Paper*, is highly misleading.[96] Below in Table 5.3, we have reproduced the information contained in Table E-1. Note that we have excluded the high and low estimates of the return on the market provided by Capital Research in February 2012 since the variation in returns is completely attributable to different assumptions about the value of distributed franking credits. In particular:[97]

- the low value assumes a net value for theta of zero; and
- the high value assumes a net value for theta of 0.5.

Only the middle estimate of the return on the market produced by Capital Research (February 2012) uses a value for theta that was consistent with a gamma value of 0.25. Table 5.3 shows that when outliers are excluded (ie, the highest and lowest values are removed) recent estimates of the return on the market using DGM analysis are broadly similar – ie, they range between 11.7 and 12.29 per cent – and indicative of an expected return on the market of around 12 per cent.

---

94 Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 144.

95 AER, *Consultation Paper*, page 94.

96 AER, *Consultation Paper*, page 94.

97 Capital Research, *Forward Estimates of the Market Risk Premium: Update*, March 2012 pages 28-29.

Table 5.1
US return on equity decisions for energy utilities

	Electricity Utilities		Gas Utilities	
Year	**Return on Equity (%)**	**Number of RoE**	**Return on Equity (%)**	**Number of RoE**
1998	11.66	10	11.51	10
1999	10.77	20	10.66	9
2000	11.43	12	11.39	12
2001	11.09	18	10.95	7
2002	11.16	22	11.03	21
2003	10.97	22	10.99	25
2004	10.75	19	10.59	20
2005	10.54	29	10.46	26
2006	10.36	26	10.43	16
2007	10.36	39	10.24	37
2008	10.46	37	10.37	30
2009	10.48	39	10.19	29
2010	10.34	59	10.08	37
2011	10.22	41	9.92	16
2012 Q1	10.84	12	9.63	5
Average	10.60		10.49	
Maximum	11.66		11.51	
Minimum	10.22		9.63	

Notes: Return on equity is in per cent per annum.
Source: NERA, Estimating the Cost of Equity under the CAPM: Expert report of Gregory Houston for Johnson Winter & Slattery, November 2012, pages 28-29.

Table 5.2
Market capitalisation-weighted estimates in per cent assuming mean-reversion in parameters

Period	N	Cost of equity	Long-term growth	Return on equity	Dividend yield	Risk-free rate	Market risk premium	Bloomberg r_e	Bloomberg ERP
2H02	143	10.3	5.9	19.6	3.9	5.6	4.7		
1H03	146	10.0	5.4	19.5	4.2	5.1	4.8		
2H03	150	10.3	5.8	19.6	4.3	5.6	4.7		
1H04	156	10.8	6.2	20.4	4.6	5.7	5.1		
2H04	164	10.8	6.1	19.3	4.6	5.5	5.3		
1H05	186	10.6	5.9	19.5	4.1	5.4	5.2		
2H05	168	10.6	5.4	21.7	4.0	5.3	5.3		
1H06	164	9.7	4.4	22.6	3.9	5.5	4.2		
2H06	188	10.2	4.8	22.5	4.3	5.7	4.5		
1H07	232	10.2	5.2	20.8	3.6	5.9	4.3		
2H07	253	10.2	5.4	21.0	3.7	6.1	4.1		
1H08	265	10.5	5.9	19.5	4.5	6.3	4.3		
2H08	244	10.7	5.5	18.5	5.2	5.4	5.3	13.2	7.8
1H09	228	11.3	6.4	17.7	5.4	4.6	6.7	16.0	11.4
2H09	263	10.6	6.2	16.9	4.4	5.5	5.2	12.0	6.5
1H10	283	10.5	6.0	17.9	4.1	5.5	5.0	13.7	8.2
2H10	274	10.8	5.9	18.6	4.3	5.2	5.7	15.6	10.4
1H11	281	10.7	5.7	18.5	4.4	5.4	5.3	14.7	9.3
2H11	261	11.1	6.1	18.0	4.7	4.3	6.8	14.4	10.0
1H12	267	11.2	6.3	17.3	4.7	3.7	7.6	12.7	9.0
2H12	251	11.0	5.8	17.0	4.7	3.1	7.9	11.4	8.3
Average	217	10.6	5.7	19.3	4.4	5.3	5.3	13.7	9.0
2H02-1H08	185	10.3	5.5	20.5	4.1	5.6	4.7		
2H08-2H12	261	10.9	6.0	17.8	4.7	4.7	6.2	13.7	9.0

Notes: The cost of equity is a market capitalisation-weighted average of the average cost of equity estimates for each firm during the six month period. The risk-free rate is the average of daily annualised yields on 10-year government bonds. The market risk premium is then the difference between the market capitalisation-weighted average cost of equity and the average risk-free rate. The Bloomberg cost of equity is the average of the daily estimates of the cost of equity for Australia provided by Bloomberg, and the Bloomberg equity risk premium is simply the difference between the Bloomberg cost of equity estimate and the risk-free rate reported in the table. The dividend yield is the estimate from the first two forecast years, not the long-term dividend yield.

Source: SFG, Dividen discount model estimates of the cost of equity, June 2013.

Table 5.3
Recent DGM estimates of the return to the market

	Dividend yield	Dividend growth	Return on market
Lally (March 2013)	5.34	3.82-7.31	9.16 – 12.65
NERA (Feb 2012)	6.03 – 6.05	5.65	11.68 – 11.71
NERA (Feb 2012)	6.03 – 6.05	5.65	11.68 – 11.71
NERA (Mar 2012)	6.03 – 6.05	5.65	11.68 – 11.71
CEG (November 2012)	5.34	6.60	11.94
Capital Research (Feb 2012)	5.23	7.00	12.15
CEG (March 2012)	5.68	6.60	12.29
Capital Research (Mar 2012)	6.29	7.00	13.29

Notes : All figures are in per cent per annum.
Source: AER, Consultation Paper Table E-1, page 94.

5.4. Assessment

The use of the DGM to estimate the cost of equity for a regulated energy utility has a number of distinct advantages:

- the theoretical basis of the model, namely that the price of an asset is equal to the present value of its future cash flows, is widely accepted;
- the analysis provides a direct measure of investors' forward looking expectations;
- it does not rely on a pricing model; and
- it does not require one make an assumption about whether Australian capital markets are integrated with or segmented from international markets.

While there are legitimate concerns with estimating the inputs that the DGM requires these concerns are not unique to the DGM and are shared with all financial models.

Because the DGM produces a single estimate of the cost of equity that is a complicated average of the costs of equity over the next year and over all future years, use of the DGM can produce a *biased* estimate of the currently prevailing cost of equity in any one year.

Over time, however, the DGM should produce estimates of the cost of equity that are, on average, *unbiased*.

The evidence that SFG provides suggests that estimates of the cost of equity generated by the DGM are relatively stable over time. In other words, their evidence suggests that the estimates are relatively *precise*.

6. Independent Expert Reports

Independent expert reports, authored by experienced corporate advisers and valuers, value transactions such as mergers and acquisitions. These reports are provided by specialist valuers, such as Grant Samuel and Lonergan Edwards, or corporate value advisers, such as the major accounting firms.

Independent experts in forming an opinion on the value of an asset or share, generally either apply a capitalisation multiple to a current or prospective earnings or cash flow value, or apply discounted cash flow analysis. In cases where discounted cash flow analysis is undertaken, the independent expert derives an estimate of the weighted average cost of capital for the firm, and, as a component of this, explicitly derives a cost of equity that is appropriate given the risk of equity.

6.1. Expert Reports

Independent expert reports provide another potential source of information on the cost of equity for a regulated energy network service provider. They are potentially useful for the following reasons:

- they are provided by recognised experts in their field;
- they are provided by experts that have a legal obligation to be independent and provide unbiased valuations; and
- they are publically available.

Experts preparing independent expert reports which express an opinion as required by the Corporations Act or ASX Listing Rules should be experts in their field. Section 9 of the Corporations Act defines an expert as:[98]

> 'a person whose profession or reputation gives authority to a statement made by him or her.'

ASIC requires that experts who prepare independent expert reports:

- cannot be associated with certain parties who have interests in the transaction for which the independent expert report is prepared;
- must disclose certain relevant interests and relationships when preparing reports required by the Corporations Act; and
- must hold an Australian financial services licence which imposes obligations to manage potential conflicts of interest.

The Australian Securities and Investment Commission (ASIC) Regulatory Guide 111 advises that it will consider regulatory action if it considers there are material issues about the adequacy and completeness of an independent expert's analysis, or if it has concerns about

[98] Section 9, *Corporations Act, 2001*.

the expert's independence. Regulatory action may include revocation or suspension of the independent expert's licence.[99]

Independent valuation reports therefore represent a reflection of market opinion with respect to the estimation of the cost of equity because:

- independent expert reports typically have well referenced and comprehensive appendices that set out the cost of capital parameters and assumptions;
- are provided by accredited experts that are subject to an explicit regime of regulation, comprising both formal statutory rules and less formal guidelines; and
- they are produced to provide information for interested parties on substantial market transactions such as mergers and acquisitions.

Finally, independent expert reports are public documents that can be accessed through providers such as the Connect 4 database, a web-based system, operated and maintained by Thomson Reuters, which contains reports on companies listed on the Australian Stock Exchange (ASX).

6.2. Discussion

A shortcoming of independent expert reports is that there are relatively few transactions relating specifically to regulated energy infrastructure. As a result, any independent expert reports relating specifically to regulated energy infrastructure, besides being few in number, may not be indicative of current market conditions.

However, a wider set of reports can be used to make inferences about market-wide cost of capital issues, such as:

- the choices that practitioners make in selecting a value for the risk-free rate;
- the views of practitioners on the expected return on the market; and
- the views of practitioners of whether the market places a value on imputation credits distributed.

We also note that the AER, in its September 2012 *Draft Decision* for Victorian gas distribution businesses, stated that:[100]

> 'expert valuers … apply the MRP, so the AER considers (they) can make informed judgments about the MRP. McKenzie and Partington supported this view in their February 2012 MRP report.'

Thus the AER and at least two of its advisors have identified independent expert reports as being capable of providing information that is useful in determining the cost of equity to the

---

99 ASIC, *Regulatory Guide 111 - Content of expert reports*, March 2011, paragraph 111.128.

100 AER, *Draft decision | Multinet 2013–17 | Draft decision appendices*, September 2012, page 32.

McKenzie, M. and G. Partington, *Supplementary report on the MRP*, SIRCA Limited, February 2012, page 17.

market, a parameter that can be important in determining the cost of equity for a regulated energy utility.

6.3. Assessment

The use of independent expert reports offers a number of attractions. In particular:

- many transactions require that an independent expert report be produced;
- independent experts face strong incentives to provide accurate responses;
- independent experts generally state how they have derived their estimate of the cost of equity;
- independent experts generally state whether they place a value on imputation credits; and
- independent experts generally state whether they adjust the cost of equity that the SL CAPM generates.

Independent experts often use the SL CAPM to estimate the cost of equity but frequently make adjustments that take the final cost of equity that they choose away from that implied by a sole use of the model. It is reasonable to assume that the adjustments that experts make are designed to reduce the bias that can result from using the SL CAPM. Use of an adjustment, however, may lower the precision with which the model estimates the cost of equity.

We have no information on how experts trade-off between bias and precision but we think it likely that expert reports provide estimates of the cost of equity that:

- are likely to be less *biased* than estimates produced using the SL CAPM; but
- are likely to be less *precise*.

We note, however, that few experts reports have been produced in recent years for regulated energy infrastructure in Australia. Thus it may be difficult to extract current estimates of the cost of equity for a regulated utility directly from an expert report or reports.

We note, on the other hand, that one can extract important information from independent expert reports that do not focus on regulated energy infrastructure about:

- the choices that practitioners make in selecting a value for the risk-free rate;
- the views of practitioners on the expected return on the market; and
- the views of practitioners of whether the market places a value on imputation credits distributed.

7. Conclusions

This report has been prepared for the Energy Networks Association (ENA) by NERA Economic Consulting (NERA). The ENA has asked NERA to provide a review of the empirical evidence on:

- the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM);
- the Black CAPM;
- the Fama-French three-factor model;
- the dividend growth model (DGM); and
- independent expert reports.

In each case we have been asked to assess the strengths and weaknesses of each approach to the issue of estimating the cost of equity for a regulated energy utility.

Attached to each pricing model are strengths and weaknesses. These strengths and weaknesses depend on the *bias* that may result from the use of a pricing model and the *precision* with which the use of a model will allow one to estimate the cost of equity. An estimator of a parameter is said to be unbiased if the expected value of the estimator matches the parameter and is said to be biased if the expected value differs from the parameter.[101]The precision of a random variable is the reciprocal of its variance.[102]

All else constant an unbiased estimator will be preferred to a biased estimator and all else constant a more precise estimator will be preferred to a less precise estimator. Restrictive models are likely to produce estimates that are more precise but also estimates that may be biased.[103] Less restrictive models are likely to produce estimates that are less precise but also estimates that are less likely to be biased.[104] Similarly, models that contain more parameters,

---

[101] See, for example:

Hamilton, J.D., *Time series analysis*, Princeton University Press, Princeton, NJ, 1994, page 741.

[102] This definition, standard in the statistics literature, differs from the Oxford Dictionary definition of precision which is:

> 'accuracy or exactness.'

In statistics a precise estimator can be exact but inaccurate. As Davidson and MacKinnon note, however,

> 'it is sometimes more intuitive to think in terms of precision than in terms of variance.'

We agree and so use the terms precise and precision to render our discussion easier to follow.

Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 144.

Fowler, F.G. and H.W. Fowler, *Pocket Oxford Dictionary*, Oxford University Press, Oxford, 1966, page 623.

[103] See, for example:

Toro-Vizcorrondo, C. and T.D. Wallace, *A test of the mean square error criterion for restrictions in linear regression*, Journal of the American Statistical Association, 1968, pages 558-572.

[104] The Black CAPM is a less restrictive model than the SL CAPM. The SL CAPM restricts the zero-beta premium to be zero while the Black CAPM does not.

but that are not necessarily less restrictive, are likely to produce estimates that are less precise but also estimates that are less likely to be biased.[105]

In principle, one may be willing to trade off bias for precision. In practice, though, one may wish to demonstrate that a trade-off will convey benefits. Demonstrating that there will be benefits from trading off bias for precision may be difficult.[106]

We conclude that the SL CAPM:

- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a low-beta or value stock (high-beta or growth stock); but
- is likely to provide cost of equity estimates that are relatively more *precise* than other sources of evidence because it is such a restrictive model.

A stock's beta is a measure of the sensitivity of the stock's return to the return on the market portfolio.[107] A value (growth) stock is a stock whose book value is high (low) relative to its market value.

We conclude that the Black CAPM:

- is likely to provide an approximately *unbiased* estimate of the return required on a stock that is neither a value nor a growth stock; but
- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a value stock (growth stock); and
- because it is a more general model than the SL CAPM, it will likely produce less *precise* estimates than the SL CAPM.

We conclude that the Fama-French three-factor model:

- is likely to provide an *unbiased* estimate of the return required on a stock that is a value or a growth stock and that is neither a low-market-beta or high-market-beta stock; but
- is likely to provide a downwardly (upwardly) *biased* estimate of the return that the market requires on a low-market-beta stock (high-market-beta-stock); and

---

[105] The Fama-French three-factor model contains more parameters than the SL CAPM. So it is tempting to infer that the Fama-French model is a less restrictive model than the SL CAPM. This, however, is not the case. The two models are not nested – meaning one model is not a special case of the other. For a discussion of what it means for models to be nested, see:

Davidson, R. and J. G. MacKinnon, *Estimation and inference in econometrics*, Oxford University Press, Oxford, 1993, page 381.

[106] See, for example:

Wheatley, S.M., *Evaluating asset pricing models*, paper presented at the American Finance Association Meetings, Chicago, IL, 1998.

[107] See, for example:

Sharpe, W.F. and G.J. Alexander, *Fundamentals of investments*, Prentice Hall, Englewood Cliffs, NJ, 1989, page 644.

- because it is a more model that contains more parameters than the SL CAPM, will likely produce less *precise* estimates of the cost of equity than the SL CAPM.

The DGM delivers the single internal rate of return that will discount the future dividends that a stock or portfolio is expected to generate back to its current market price. This internal rate of return will be a complicated average of the expected returns to the stock or portfolio over the next year and over all future years. The major source of uncertainty in determining the return that the DGM will deliver is in determining how the dividends that the stock or portfolio will generate will grow over time. We conclude that the use of the DGM:

- is likely to produce estimates of the return required on a stock that are, on average through time, *unbiased* but that may, at any particular point in time, be *biased*; and
- will deliver estimates of the return required on a stock that are *precise* if an estimate of the future growth in dividends can be constructed that is *precise*.

Independent experts often use the SL CAPM to estimate the cost of equity but frequently make adjustments that take the final cost of equity that they choose away from that implied by a sole use of the model. It is reasonable to assume that the adjustments that experts make are designed to reduce the bias that can result from using the SL CAPM. Use of an adjustment, however, may lower the precision with which the model estimates the cost of equity. We have no information on how experts trade off between bias and precision but we think it likely that expert reports provide estimates of the cost of equity that:

- are likely to be less *biased* than estimates produced using the SL CAPM; but
- are likely to be less *precise*.

We note, however, that few experts reports have been produced in recent years for regulated energy infrastructure in Australia.

Thus it may be difficult to extract current estimates of the cost of equity for a regulated utility directly from an expert report or reports. We note, on the other hand, that one can extract important information from independent expert reports that do not focus on regulated energy infrastructure about:

- the choices that practitioners make in selecting a value for the risk-free rate;
- the views of practitioners on the expected return on the market; and
- the views of practitioners of whether the market places a value on imputation credits distributed.

Appendix A. Terms of Reference

TERMS OF REFERENCE – SUPPORT FOR COST OF EQUITY EVIDENCE

Background

The Australian Energy Regulator (AER) is developing Rate of Return Guidelines that will form the basis of the regulated rate of return applied in energy network decisions. The AER published an issues paper in late December 2012 and a formal consultation paper in early May 2013 under the recently revised National Electricity Rules (NER) and National Gas Rules (NGR).

The AER undertook its last review of the weighted average cost of capital (WACC) in 2009 (under a previous version of the NER). The Energy Networks Association (ENA) established a Cost of Capital Subgroup (CoCS) and working groups– including, for instance, the overall WACC work stream – to actively engage in the *Rate of Return Guidelines* process.

The new NER and NGR require the AER to estimate the cost of equity for a regulatory control period that contributes to the achievement of the *allowed rate of return objective*: [108]

> '*[t]he rate of return for a [Service Provider] is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applied to the [Service Provider] in respect of the provision of [services]*.'

Under the previous NER, the AER was required to estimate the cost of equity for electricity network businesses using the Sharpe-Lintner version of the capital asset pricing model (CAPM). Although the previous NGR did not mandate the use of the Sharpe-Lintner CAPM, in practice the AER also applied this approach in gas network decisions.

The new NER and NGR now require the AER to consider a wider range of relevant evidence than under the former NER and NGR, including having regard to multiple financial models. For instance, clause 6.5.2 of the NER states:[109]

> '*(e) In determining the allowed rate of return, regard must be had to:*
>
> *(1) relevant estimation methods, financial models, market data and other evidence;*
>
> *(2) the desirability of using an approach that leads to the consistent application of any estimates of financial parameters that are relevant to the estimates of, and that are common to, the return on equity and the return on debt; and*
>
> *(3) any interrelationships between estimates of financial parameters that are relevant to the estimates of the return on equity and the return on debt.*

---

[108] NER 6.5.2(c), 6A.6.2(c) and NGR 87 (3).

[109] Rule 87 in the NGR contains identical provisions to clause 6.5.2 in the NER.

> ...
>
> ***Return on equity***
>
> *(f) The return on equity for a regulatory control period must be estimated such that it contributes to the achievement of the allowed rate of return objective.*
>
> *(g) In estimating the return on equity under paragraph (f), regard must be had to the prevailing conditions in the market for equity funds*.'

As further detailed below, the ENA would like to engage you to provide your opinion on how the cost of equity under prevailing conditions in the market for equity funds could best be established having regard to all the available evidence within the scope of the *allowed rate of return objective*.

Do you agree that the following models and other sources of evidence are the main candidates for best establishing the cost of equity under prevailing conditions in the market for equity funds:

- Sharpe-Lintner CAPM (SL CAPM);
- Black CAPM;
- Fama French three factor model (FF3FM);
- Dividend growth model (DGM); and
- independent expert reports.

The ENA will engage a consultant to provide a report that proposes and applies a framework that distils this evidence into a final cost of equity estimate/range. To support this final report, the ENA requires a consultant to critically analyse the academic and practitioner support for each source of model and non-model evidence.

Scope of work

The ENA requests your opinion on each of the four cost of equity models referred to above (i.e. the SL CAPM, Black CAPM, FF3FM and DGM) and other sources of non-model evidence (ie. independent expert reports) for energy regulatory purposes covering the following points:

- The academic, market practitioner and regulatory support for each model and non-model source of evidence. In doing so, consider:
  a) The strengths and weaknesses of each source of evidence;
  b) Comments raised about each source of evidence in relevant domestic and international regulatory determinations;
  c) The differences between each source of evidence, including consistency between parameter estimates; and
  d) The rationale for each source of evidence, including whether certain evidence builds on and improves other evidence.

The consultant is also expected to liaise with other consultants engaged by the ENA, where required.

The ENA requests the consultant to provide a report which must:

- Attach these terms of reference and the qualifications (in the form of CV(s) of the person(s) preparing the report;
- Identify any current or potential future conflicts of interest;
- Comprehensively set out the bases for any conclusions made;
- Only rely on information or data that is fully referenced and could be made reasonably available to the AER or others;
- Document the methods, data, adjustments, equations, statistical package specifications/printouts and assumptions used in preparing your opinion;[110]
- Include specified wording at the beginning of the report stating that "[the person(s)] acknowledge(s) that [the person(s)] has read, understood and complied with the Federal Court of Australia's Practice Note CM 7, Expert Witnesses in Proceedings in the Federal Court of Australia" as if your brief was in the context of litigation;
- Include specified wording at the end of the report to declare that "[the person(s)] has made all the inquiries that [the person(s)] believes are desirable and appropriate and that no matters of significance that [the person(s)] regards as relevant have, to [the person(s)] knowledge, been withheld"; and
- State that the person(s) have been provided with a copy of the Federal Court of Australia's "Guidelines for Expert Witnesses in Proceeding in the Federal Court of Australia" and that the Report has been prepared in accordance with those Guidelines, refer to Annexure A to these Terms of Reference or alternatively online at <*http://www.federalcourt.gov.au/law-and-practice/practice-documents/practice-notes/cm7*>.

Timeframe

The following timeframe provides a guide in relation to what work is expected to be undertaken:

- Draft report by 5pm Friday 7 June 2013, also to be circulated to the COCS for comments;
- Address in the report, potential issues raised by the AER in its Consultation Paper; and
- Deliver a final report on or before 5pm 14 June 2013, ahead of the deadline for submissions in response to the AER's consultation paper (21 June 2013).

Fees

The consultant is requested to propose:

- A fixed total cost of the project and hourly rates for the proposed project team should additional work be required;

[110] Note: this requires you to reveal information that you might otherwise regard as proprietary or confidential and if this causes you commercial concern, please consult us on a legal framework which can be put in place to protect your proprietary material while enabling your work to be adequately transparent and replicable.

- The staff who will provide the strategic analysis and opinion;
- Declare the absence of any relevant conflict of interest in undertaking the project; and
- Indicate preparedness to enter into a confidentiality agreement regarding research and findings.

Any changes to the scope of the consultancy must be agreed with the ENA before the quotation is submitted. Miscellaneous costs such as travel and accommodation will be reimbursed, provided that they are agreed with the ENA beforehand.

Contacts

Any questions regarding this terms of reference should be directed to:

Nick Taylor (Jones Day)

Email: njtaylor@jonesday.com

Phone: 02 8272 0500.

Annexure A

FEDERAL COURT OF AUSTRALIA
Practice Note CM 7
EXPERT WITNESSES IN PROCEEDINGS IN THE FEDERAL COURT OF AUSTRALIA

1. Rule 23.12 of the Federal Court Rules 2011 requires a party to give a copy of the following guidelines to any witness they propose to retain for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based on the specialised knowledge of the witness (see **Part 3.3 - Opinion** of the *Evidence Act 1995* (Cth)).

2. The guidelines are not intended to address all aspects of an expert witness's duties, but are intended to facilitate the admission of opinion evidence[111], and to assist experts to understand in general terms what the Court expects of them. Additionally, it is hoped that the guidelines will assist individual expert witnesses to avoid the criticism that is sometimes made (whether rightly or wrongly) that expert witnesses lack objectivity, or have coloured their evidence in favour of the party calling them.

Guidelines

1. General Duty to the Court[112]

1.1 An expert witness has an overriding duty to assist the Court on matters relevant to the expert's area of expertise.

1.2 An expert witness is not an advocate for a party even when giving testimony that is necessarily evaluative rather than inferential.

1.3 An expert witness's paramount duty is to the Court and not to the person retaining the expert.

2. The Form of the Expert's Report[113]

2.1 An expert's written report must comply with Rule 23.13 and therefore must

(a) be signed by the expert who prepared the report; and

(b) contain an acknowledgement at the beginning of the report that the expert has read, understood and complied with the Practice Note; and

(c) contain particulars of the training, study or experience by which the expert has acquired specialised knowledge; and

(d) identify the questions that the expert was asked to address; and

---

111 As to the distinction between expert opinion evidence and expert assistance see *Evans Deakin Pty Ltd v Sebel Furniture Ltd* [2003] FCA 171 per Allsop J at [676].

112 The "*Ikarian Reefer*" (1993) 20 FSR 563 at 565-566.

113 Rule 23.13.

(e) set out separately each of the factual findings or assumptions on which the expert's opinion is based; and

(f) set out separately from the factual findings or assumptions each of the expert's opinions; and

(g) set out the reasons for each of the expert's opinions; and

(h) comply with the Practice Note.

2.2 The expert must also state that each of the expert's opinions is wholly or substantially based upon the expert's specialised knowledge[114].

2.3 At the end of the report the expert should declare that "[the expert] has *made all the inquiries that* [the expert] *believes are desirable and appropriate and that no matters of significance that* [the expert] *regards as relevant have, to* [the expert's] *knowledge, been withheld from the Court*."

2.4 There should be included in or attached to the report the documents and other materials that the expert has been instructed to consider.

2.5 If, after exchange of reports or at any other stage, an expert witness changes the expert's opinion, having read another expert's report or for any other reason, the change should be communicated as soon as practicable (through the party's lawyers) to each party to whom the expert witness's report has been provided and, when appropriate, to the Court[115].

2.6 If an expert's opinion is not fully researched because the expert considers that insufficient data are available, or for any other reason, this must be stated with an indication that the opinion is no more than a provisional one. Where an expert witness who has prepared a report believes that it may be incomplete or inaccurate without some qualification, that qualification must be stated in the report.

2.7 The expert should make it clear if a particular question or issue falls outside the relevant field of expertise.

2.8 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the opposite party at the same time as the exchange of reports[116].

3. Experts' Conference

3.1 If experts retained by the parties meet at the direction of the Court, it would be improper for an expert to be given, or to accept, instructions not to reach agreement. If, at a meeting directed by the Court, the experts cannot reach agreement about matters of expert opinion, they should specify their reasons for being unable to do so.

PA KEANE
Chief Justice
1 August 2011

---

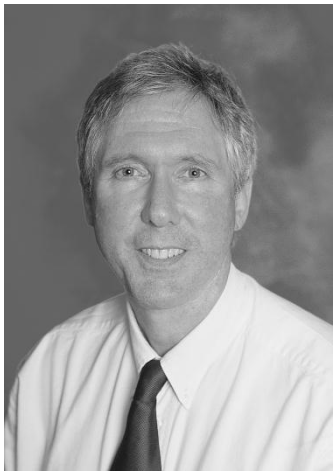
[114] *Dasreef Pty Limited v Nawaf Hawchar* [2011] HCA 21.

[115] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565

[116] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565-566. See also Ormrod *"Scientific Evidence in Court"* [1968] Crim LR 240

Appendix B. Curricula Vitae

Simon M. Wheatley



5 Maple Street
Blackburn VIC 3130
Tel: +61 3 9878 7985
E-mail: swhe4155@bigpond.net.au

Overview

Simon is a consultant and was until 2008 a Professor of Finance at the University of Melbourne. Since 2008, Simon has applied his finance expertise in investment management and consulting outside the university sector. Simon's interests and expertise are in individual portfolio choice theory, testing asset-pricing models and determining the extent to which returns are predictable. Prior to joining the University of Melbourne, Simon taught finance at the Universities of British Columbia, Chicago, New South Wales, Rochester and Washington.

Personal

Nationalities:	U.K. and U.S.
Permanent residency:	Australia

Employment

- Special Consultant, NERA Economic Consulting, 2009-present
- External Consultant, NERA Economic Consulting, 2008-2009
- Quantitative Analyst, Victorian Funds Management Corporation, 2008-2009
- Adjunct, Melbourne Business School, 2008
- Professor, Department of Finance, University of Melbourne, 2001-2008
- Associate Professor, Department of Finance, University of Melbourne, 1999-2001
- Associate Professor, Australian Graduate School of Management, 1994-1999
- Visiting Assistant Professor, Graduate School of Business, University of Chicago, 1993-1994

- Visiting Assistant Professor, Faculty of Commerce, University of British Columbia, 1986
- Assistant Professor, Graduate School of Business, University of Washington, 1984-1993

Education

- Ph.D., University of Rochester, USA, 1986; Major area: Finance; Minor area: Applied statistics; Thesis topic: Some tests of international equity market integration; Dissertation committee: Charles I. Plosser (chairman), Peter Garber, Clifford W. Smith, Rene M. Stulz
- M.A., Economics, Simon Fraser University, Canada, 1979
- M.A., Economics, Aberdeen University, Scotland, 1977

Publicly Available Reports

The Cost of Equity for a Regulated Energy Utility: A Response to the QCA Discussion Paper on the Risk-Free Rate and the MRP: A report for United Energy and Multinet Gas, March 2013, http://www.qca.org.au/files/CI-UEM-SubNERA-CCR1213-0413.pdf

The Cost of Equity for a Regulated Energy Utility: A report for Multinet, February 2013, http://www.erawa.com.au/cproot/11197/2/20130312%20-%20D103642%20-%20Guidelines%20for%20the%20Rate%20of%20Return%20for%20Gas%20Transmission%20and%20Distribution%20Networks%20-%20United%20Energy%20and%20Multinet%20Gas.pdf

Prevailing Conditions and the Market Risk Premium: A report for APA Group, Envestra, Multinet & SP AusNet, March 2012, http://www.aer.gov.au/content/item.phtml?itemId=753605&nodeId=418ee68d5b881d58515e4f39d9d3aee3&fn=G-5%20NERA%20%20Prevailing%20Conditions%20and%20the%20Market%20Risk%20Premium%20March%202012.pdf

The Market Risk Premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy, 20 February 2012, http://www.aer.gov.au/content/item.phtml?itemId=752660&nodeId=fe0280e7e2113c467dfc4b3b076e1623&fn=Vic%20DNSPs%20(NERA)%20-%2020%20February%202012.pdf

Cost of Equity in the ERA DBNGP Draft Decision: A report for DBNGP, 17 May 2011, http://www.erawa.com.au/cproot/9669/2/20110620%20-%20DBNGP%20(WA)%20%20-%20Sub%2055%20-%20Att%207%20-%20NERA%20Economic%20Consulting%20Cost%20of%20equity%20in%20the%20draft%20decision.pdf

The Market Risk Premium: A report for Multinet Gas and SP AusNet, 29 April 2011, http://www.aer.gov.au/content/index.phtml/itemId/745782

Cost of Capital for Water Infrastructure Company Report for the Queensland Competition Authority, 28 March 2011, http://www.qca.org.au/files/W-NERA-EconomicConsulting-FinalReport-WACC-0411.pdf

The Cost of Equity: A report for Orion, 2 September 2010, http://www.comcom.govt.nz/assets/Pan-Industry/Input-Methodologies/Draft-Reasons-Papers/Draft-Reasons-EDBs/Draft-Determination-X-Sub/Orion-Cross-Submission-Attachment-on-EDBs-and-GPBs-Input-Methodologies-Draft-Determination-and-Reasons-Paper-NERA-Report-2-September-2010.pdf

New Gamma Issues Raised by AER Expert Consultants: A report for JGN, 17 May 2010, http://www.aer.gov.au/content/item.phtml?itemId=736652&nodeId=dea014515519350384275dccc6b56018&fn=JGN%20further%20submission%20on%20gamma%20(18%20May%202010).pdf

The Required Rate of Return on Equity for a Gas Transmission Pipeline: A Report for DBP, 31 March 2010, http://www.erawa.com.au/cproot/8512/2/20100503%20D29252%20DBNGP%20-%20Submission%208%20-%20Annexure%201%20-%20The%20Required%20Rate%20of%20Return%20on%20Equity%20for%20a%20Gas%20Transmission%20Pipeline.pdf

Jemena Access Arrangement Proposal for the NSW Gas Networks: AER Draft Decision: A report for Jemena, 19 March 2010, http://www.aer.gov.au/content/item.phtml?itemId=735229&nodeId=4dc041cfe6e30a2c2b91e833cad31191&fn=Appendix%205.1%20-%20NERA%20-%20FAMA%20French%20Report.pdf

Payout Ratio of Regulated Firms: A report for Gilbert + Tobin, 5 January 2010, http://www.aer.gov.au/content/item.phtml?itemId=735236&nodeId=10e87413b13d1da23cd55faf20a6918d&fn=Appendix%206.3D%20-%20NERA%20(4%20Jan%2010,%20ETSA)%20Payout%20ratio%20of%20regulated%20firms.pdf

Review of Da, Guo and Jagannathan Empirical Evidence on the CAPM: A report for Jemena Gas Networks, 21 December 2009, http://www.ipart.nsw.gov.au/files/Submission%20-%20Alternative%20approaches%20to%20the%20determination%20of%20the%20cost%20of%20equity%20-%20Jemena%20-%20Sandra%20Gamble%20-%2022%20December%202009%20-%20APD%20-%20Website.PDF

The Value of Imputation Credits for a Regulated Gas Distribution Business: A report for WA Gas Networks, 18 August 2009, summarized in: http://www.erawa.com.au/cproot/8357/2/20100215%20WAGN%20-%20Proposed%20Revisions%20to%20the%20AA%20for%20the%20WAGN%20Gas%20Distribution%20Systems%20Submission%20-%20Public%20Version.pdf

Cost Of Equity - Fama-French Three-Factor Model Jemena Gas Networks (NSW), 12 August 2009, http://www.aer.gov.au/content/item.phtml?itemId=730699&nodeId=4fcc57398775fe84685434e0b749d76a&fn=Appendix%209.1%20-%20NERA%20-%20Cost%20of%20equity%20-%20Fama-French%20Model.pdf

Estimates of the Cost of Equity: A report for WAGN, 22 April 2009, summarized in: http://www.erawa.com.au/cproot/8357/2/20100215%20WAGN%20-%20Proposed%20Revisions%20to%20the%20AA%20for%20the%20WAGN%20Gas%20Distribution%20Systems%20Submission%20-%20Public%20Version.pdf

AER's Proposed WACC Statement – Gamma: A report for the Joint Industry Associations, 30 January 2009, http://www.aer.gov.au/content/item.phtml?itemId=726698&nodeId=80cf978278d317e99c34ae1878525573&fn=JIA%20Appendix%20Q%20-%20NERA%20-%20AER's%20proposed%20WACC%20statement-Gamma.pdf

The Value of Imputation Credits: A report for the ENA, Grid Australia and APIA, 11 September 2008, http://www.ena.asn.au/udocs/24092008aersub/Appendix%20K%20-%20The%20value%20of%20imputation%20credits%20-%20NERA.pdf

Consulting Experience

NERA, 2008-present

Lumina Foundation, Indianapolis, 2009

Industry Funds Management, 2010

Academic Publications

Imputation credits and equity returns, (with Paul Lajbcygier), 2012, *Economic Record* 88, 476–494.

Do measures of investor sentiment predict returns? (with Robert Neal), 1998, *Journal of Financial and Quantitative Analysis* 33, 523-547.

Adverse selection and bid-ask spreads: Evidence from closed-end funds (with Robert Neal), 1998, *Journal of Financial Markets* 1, 121-149.

Shifts in the interest-rate response to money announcements: What can we say about when they occur? (with V. Vance Roley), 1996, *Journal of Business and Economic Statistics* 14, 135-138.

International investment restrictions and closed-end country fund prices, (with Catherine Bonser-Neal, Greggory Brauer, and Robert Neal), 1990, *Journal of Finance* 45, 523-547 (reprinted in International Capital Markets Volume III, 2003, G. Andrew Karolyi and Rene M. Stulz, editors, Edward Elgar Publishing, Cheltenham, Glos).

A critique of latent variable tests of asset pricing models, 1989, *Journal of Financial Economics* 21, 177-212.

Some tests of international equity market integration, 1988, *Journal of Financial Economics* 21, 177-212 (reprinted in International Capital Markets Volume I, 2003, G. Andrew Karolyi and Rene M. Stulz, editors, Edward Elgar Publishing, Cheltenham, Glos).

Some tests of the consumption-based asset pricing model, 1988, *Journal of Monetary Economics* 22, 193-215.

Working Papers

An evaluation of some alternative models for pricing Australian stocks (with Paul Lajbcygier), 2009.

Intertemporal substitution, small-sample bias, and the behaviour of U.S. household consumption (with Kogulakrishnan Maheswaran and Robert Porter), 2007.

Keeping up with the Joneses, human capital, and the home-equity bias (with En Te Chen), 2003.

Evaluating asset pricing models, 1998.

Time-non-separable preferences or artifact of temporal aggregation? (with Robert Porter), 2002.

Testing asset pricing models with infrequently measured factors, 1989.

Refereeing Experience

Referee for Accounting and Finance, the Australian Journal of Management, Economic Letters, Financial Analysts Journal, Financial Management, Journal of Accounting and Economics, Journal of Business, Journal of Empirical Finance, Journal of Finance, Journal of Financial and Quantitative Analysis, Journal of Financial Economics, Journal of Futures Markets, Journal of International Economics, Journal of International Money and Finance, Journal of Money, Credit, and Banking, Journal of Monetary Economics, Management Science, National Science Foundation, Pacific-Basin Finance Journal, and the Review of Financial Studies.

Program Committee for the Western Finance Association in 1989 and 2000.

Teaching Experience

International Finance, Melbourne Business School, 2008

Corporate Finance, International Finance, Investments, University of Melbourne, 1999-2008

Corporate Finance, International Finance, Investments, Australian Graduate School of Management, 1994-1999

Investments, University of Chicago, 1993-1994

Investments, University of British Columbia, 1986

International Finance, Investments, University of Washington, 1984-1993

Investments, Macroeconomics, Statistics, University of Rochester, 1982

Accounting, Australian Graduate School of Management, 1981

Teaching Awards

MBA Professor of the Quarter, Summer 1991, University of Washington

Computing Skills

User of SAS since 1980. EViews, Excel, EXP, LaTex, Matlab, Powerpoint, Visual Basic. Familiar with the Compustat, CRSP and SIRCA SPPR databases. Some familiarity with Bloomberg, FactSet and IRESS.

Board Membership

Anglican Funds Committee, Melbourne, 2008-2011

Honours

Elected a member of Beta Gamma Sigma, June 1986.

Fellowships

Earhart Foundation Award, 1982-1983

University of Rochester Fellowship, 1979-1984

Simon Fraser University Fellowship, 1979

Inner London Education Authority Award, 1973-1977

Brendan Quach

Senior Consultant

NERA Economic Consulting
Darling Park Tower 3
201 Sussex Street
Sydney NSW 2000
Tel: +61 2 8864 6502
Fax: +61 2 8864 6549
E-mail: brendan.quach@nera.com
Website: www.nera.com

Overview

Brendan Quach has eleven years' experience as an economist, specialising in network economics, and competition policy in Australia, New Zealand and Asia Pacific. Since joining NERA in 2001, Brendan has advised clients on the application of competition policy in Australia, in such industries as aviation, airports, electricity, rail and natural gas. Brendan specialises in regulatory and financial modelling and the cost of capital for network businesses. Prior to joining NERA, Brendan worked at the Australian Chamber of Commerce and Industry, advising on a number of business issues including tax policy, national wage claims and small business reforms.

Qualifications

1991-1995 **AUSTRALIAN NATIONAL UNIVERSITY**
Bachelor of Economics.
(High Second Class Honours)

1991-1997 **AUSTRALIAN NATIONAL UNIVERSITY**
Bachelor of Laws.

Career Details

2001 - **NERA ECONOMIC CONSULTING**
Economist, Sydney

1998-1999 **AUSTRALIAN CHAMBER OF COMMERCE AND INDUSTRY**
Economist, Canberra

1996 **AUSTRALIAN BUREAU OF STATISTICS**
Research Officer, Canberra

Project Experience

Industry Analysis

2011 **Energy Networks Association**
Review of the regulatory frameworks for energy networks
Brendan is currently advising the ENA on the Australian Energy Regulator's (AER's) potential Rule change proposal. Advice currently focuses on a range of issues including the propose-respond framework, expenditure incentives, the cost of capital and the potential role of judicial reviews.

2011 **MSAR Office for the Development of the Energy Sector**
Development of a New Tariff Structure
Brendan is currently leading a team reviewing Macau's current electricity tariffs. This requires NERA to model and analyse long- and short-run marginal costs, sunk costs and generation dispatch. Our work for the Macau Government will be incorporated into the potential development of new tariffs for residential, commercial and casino customers.

2010 **Industry Funds Management/Queensland Investment Corporation**
Due diligence, Port of Brisbane
Brendan was retained to advise on various regulatory and competition matters likely to affect the future financial and business performance of the Port of Brisbane, in the context of its sale by the Queensland government.

2010-2011 **Minter Ellison /UNELCO**
Review of regulatory decision by the Vanuatu regulator
Assisted in the development of an expert report on a range of matters arising from the Vanuatu regulator's decision to reset electricity prices under four concession contracts held by UNELCO. The matters considered included the methodology employed to calculate the new base price, the appropriateness of the rate of return, the decision by the regulator to reset future prices having regard to past gains/losses.

2010 **Gilbert + Tobin/Confidential – Telecommunications**
Incentive Arrangements for Regulated Telecommunications Services
Brendan provided strategic advice to Gilbert + Tobin on possible regulatory arrangements that allow for the efficient delivery of fixed line telecommunications services in the context of the government mandated roll out the National Broadband Network.

2009-10 **EnergyAustralia – NSW Electricity Distribution**

Review of Public Lighting Services

Brendan provided advice to EnergyAustralia during its electricity distribution price review on the provision of public lighting services. Our work provided strategic and regulatory advice to EnergyAustralia during the appeal of the AER's revenue determination for the 2009-2014 period.

2009 **CitiPower/Powercor**

Efficiency carryover mechanisms

Assisted in the development of an expert report submitted to the AER on the consistency of carrying-forward accrued negative amounts arising from the application of the ESC's efficiency carryover mechanism with the National Electricity Law and the National Electricity Rules.

2009 **Prime Infrastructure**

Sale of Dalrymple Bay Coal Terminal (DBCT)

Brendan provided regulatory advice to a number of potential bidders for the assets of DBCT. Advice included an assessment of the rate of return parameters, depreciation, regulatory modelling and the regulatory arrangements in Queensland.

2008-09 **MSAR Office for the Development of the Energy Sector**

Review of Electricity Cost and Tariff Structures

Review of current and projected costs of electricity provision in Macau, including modelling and analysis of marginal costs and sunk cost attribution to various consumer classes. Our work for the Macau Government has incorporated the development of potential tariff structures (specifically rising block tariff structures) and scenarios, including modelling revenue recovery and cross subsidies.

2008 **Singaporean Ministry for Trade and Industry**

Electricity Industry Review

NERA was retained by the Singaporean Ministry for Trade and Industry (MTI) to provide a comprehensive review of the Singaporean electricity market. Brendan was involved in the analysis of the costs and benefits arising from the restructuring and reform of the Singaporean electricity industry since the mid 1990's, the estimated costs and benefits of future security of supply and energy diversification approaches. The project required NERA to undertake quantitative dispatch modelling of the Singaporean electricity market.

2008 **Ministerial Council Energy**
Retailer of Last Resort
Assisted in the development of a joint expert report with Allens Arthur Robinson (AAR) that: reviewed the existing jurisdictional retailer of last resort (RoLR) frameworks; advised the MCE on the development of an appropriate national policy framework for RoLR and developed a suggested base set of proposals for a national RoLR scheme.

2005-06 **Freehills/South Australian Gas Producers, NSW and South Australia**
Gas supply agreement arbitration
Assisted in the development of an economic expert report in the arbitration of the price to apply following review of a major gas supply agreement between the South Australian gas producers and a large retailer in NSW and South Australia.

2005-2006 **Australian Energy Market Commission (AEMC), Australia**
Advised the AEMC on its review of the Electricity Rules relating to transmission revenue determination and pricing, which included providing briefing papers to the Commission on specific issues raised by the review.

2005-2006 **Minter Ellison/ South West Queensland Gas Producers, Queensland**
Gas supply agreement arbitration
Advised Minter Ellison and the Producers in an arbitration of the price to apply following review of a major gas supply agreement between the South West Queensland gas producers and a large industrial customer.

2005 **International Utility, Queensland**
Generator sale, due diligence
Part of the due diligence team acting on behalf of a large international utility in the purchase of two coal fired generators in Queensland, Australia. Provided advice on the features of the Australian electricity market and regulatory environment.

2003 **Auckland City Council, New Zealand**
Rationalisation Options Study
Conducting a rationalisation options study to examine alternative business models for Metrowater. Our report assessed different vertical and horizontal integration options for Metrowater.

2003 **Metrowater, New Zealand**
Institutional Restructuring
Prepared advice for the board of the Auckland City Water and wastewater service provider, Metrowater on options for institutional and regulatory reform of the entire Auckland regional water sector.

2002 - 2003 **Rail Infrastructure Corporation, Australia**
Research to RIC on their proposed access undertaking.
Provided research and advice into various components of RICs proposed access undertaking with the ACCC including the cost of capital, asset valuation and pricing principles.

2002 **Argus Telecommunications, Australia**
Critique of CIE's bandwidth pricing principles.
Provided a critique of a CIE report on bandwidth pricing principles for the fibre optic networked run owned by Argus Telecommunications.

2001 **Screenrights, Australia**
Advice on valuing retransmission of local TV
A review and analysis of different methodologies in valuing retransmission of local television on pay TV services.

Regulatory and Financial Analysis

2012 **Queensland Competition Authority**
Review of the retail water regulatory models
Brendan undertook an independent quality assurance assessment of the financial models relied on by the QCA to set the regulated revenues of SunWater. The review considered: SunWater's Financial model, a model used by SunWater to calculate future electricity prices, an renewals annuity model, as well as the QCA's regulatory model. These models established a set of recommended prices for each of the 30 irrigation schemes operated by SunWater for the period 2014 to 2019.

2011 **Queensland Competition Authority**
Review of the retail water regulatory models
Undertook an independent quality assurance assessment of the models used to calculate regulated revenues for Queensland Urban Utilities, Allconnex Water, and Unitywater. The review considered: the formulation of the WACC; the intra year timing of cashflows; and the structural, computational and economic integrity of the models.

2011 **Queensland Competition Authority**
Review of the wholesale water regulatory models
Undertook an independent quality assurance assessment of the models used to calculate regulated revenues for LinkWater, Seqwater; and

WaterSecure. The review considered: the formulation of the WACC; the intra year timing of cashflows; and the structural, computational and economic integrity of the models.

2011 **Multinet Gas and SP AusNet - Gas Distribution**

Report on the market risk premium

Co-authored a report that examined a number of issues arising from the draft decision on Envestra's access proposal for the SA gas network. The report considered whether: the historical evidence supported the use of a long term average of 6 per cent; there is any evidence to warrant a MRP at it long term average; and the evidence relied on by the AER to justify its return to a MRP of 6 per cent.

2011 **Dampier to Bunbury Natural Gas Pipeline - Gas Transmission**

Cost of Equity

Co-authored two reports that updated the cost of equity for a gas transmission business and responded to issues raised by the regulator in its draft decision. The report re-estimated the cost of equity of a gas distribution business using the Sharpe Lintner CAPM, Black CAPM, Fama-French three-factor model and a zero beta version of the Fama-French three-factor model.

2010-2011 **Queensland Competition Authority**

Weighted Average Cost of Capital (WACC) for SunWater

Retained to provide two expert reports on the WACC for SunWater a Queensland rural infrastructure business. The first report considered issues pertaining to whether a single or multiple rates of return can be applied across SunWater's network segments. The second report focuses market evidence on the appropriate rate of return for SunWater.

2011 **Mallesons Stephens Jaques, on behalf of ActewAGL Distribution**

Determining the averaging period

Assisted in the development of an expert report that considered the economic and financial matters arising from the Australian Energy Regulator's decision to reject ActewAGL's proposed risk free rate averaging period.

2010 **Orion Energy, New Zealand**

Information disclosure regime

Provided advice and assistance in preparing submissions by Orion to the New Zealand Commerce Commission, in relation to the Commission's proposed weighted average cost of capital for an electricity lines businesses. Issues addressed included the financial model used to calculate the required return on equity, the appropriate term for the risk free rate and the WACC parameter values proposed by the Commission.

2010 **Ministerial Council on Energy, Smart Meter Working Group, The costs and benefits of electricity smart metering infrastructure in rural and remote communities**

This report extends NERA's earlier analysis of the costs and benefits of a mandatory roll out of smart meters, by consider the implications of a roll out in rural and remote communities in the Northern Territory, Western Australia and Queensland. The project has focused on eight case study communities and has examined the implications of prepayment metering and remoteness on the overall costs and benefits of a roll out.

2010 **Grid Australia, Submission to the AER on the proposed amendments to the transmission revenue and asset value models**

Developed and drafted a submission to the AER on the proposed amendments to the AER's post-tax revenue model (PTRM) and roll forward model (RFM). The proposal focused on a number of suggestions to simplify and increase the usability of the existing models.

2010 **Dampier to Bunbury Natural Gas Pipeline (DBNGP) - Gas Transmission**

Cost of Equity

Co-authored a report that examined four well accepted financial models to estimate the cost of equity for a gas transmission business. The report of estimating the cost of equity of a gas distribution business using the Sharpe Lintner CAPM, Black CAPM, Fama-French three-factor model and a zero beta version of the Fama-French three-factor model.

2009-10 **Jemena - Gas Distribution**

Cost of Equity

Co-authored two reports on the use of the Fama-French three-factor model to estimate the cost of equity for regulated gas distribution business. The report examined whether the Fama-French three-factor model met the dual requirements of the National Gas Code to provide an accurate estimate of the cost of equity and be a well accepted financial model. Using Australian financial data the report also provided a current estimate of the cost of equity for Jemena.

2009 **WA Gas Networks - Gas Distribution**

Cost of Equity

Co-authored a report that examined a range of financial models that could be used to estimate the cost of equity for a gas distribution business. The report of estimating the cost of equity of a gas distribution business using the Sharpe Lintner CAPM, Black CAPM, Fama-French three-factor model and Fama-French two-factor model. The report examined both the domestic and international data.

2009 **CitiPower and Powercor – Victorian Electricity Distribution**
Network Reliability Incentive Mechanism (S-factor)
Brendan provided advice to CitiPower and Powercor on the proposed changes to the operation of the reliability incentive mechanism. The advice considered the effects of the proposed changes to the operation of the two distribution network service providers. Specifically, how the 'S-factors' would be changed and implications this has to the revenue streams of the two businesses. A comparison was also made with the current ESC arrangements to highlight the changes to the mechanism.

2009 **CitiPower and Powercor – Victorian Electricity Distribution**
Network Reliability Incentive Mechanism (S-factor)
Brendan provided advice to CitiPower and Powercor on the proposed changes to the operation of the reliability incentive mechanism. The advice considered the effects of the new arrangements on the business case for undertaking a series of reliability projects. Specifically, the project estimated the net benefit to the businesses of three reliability programs.

2009 **Jemena and ActewAGL - Gas Distribution**
Cost of Equity
Co-authored a report on alternative financial models for estimating the cost of equity. The report examined the implication of estimating the cost of equity of a gas distribution business using the Sharpe Lintner CAPM, Black CAPM and Fama-French models. The report examined both the domestic and international data.

2008 **Joint Industry Associations - APIA, ENA and Grid Australia**
Weighted Average Cost of Capital
Assisted in the drafting of the Joint Industry Associations submission to the Australian Energy Regulator's weighted average cost of capital review. The submission examined the current market evidence of the cost of capital for Australian regulated electricity transmission and distribution businesses.

2008 **Joint Industry Associations - APIA, ENA and Grid Australia**
Weighted Average Cost of Capital
Expert report for the Joint Industry Associations on the value of imputation credits. The expert report was attached to their submission to the Australian Energy Regulator's weighted average cost of capital review. The report examined the current evidence of the market value of imputation credits (gamma) created by Australian regulated electricity transmission and distribution businesses.

2007-2008 **Smart Meter Working Group, Ministerial Council on Energy – Assessment of the costs and benefits of a national mandated rollout of smart metering and direct load control**

Part of a project team that considered the costs and benefits of a national mandated rollout of electricity smart meters. Brendan was primarily responsible for the collection of data and the modelling of the overall costs and benefits of smart metering functions and scenarios. The analysis also considering the likely costs and benefits associated with the likely demand responses from consumers and impacts on vulnerable customers.

2007 **Electricity Transmission Network Owners Forum (ETNOF), Submission to the AER on the proposed transmission revenue and asset value models**

Developed and drafted a submission to the AER on the proposed post-tax revenue model (PTRM) and roll forward model (RFM) that would apply to all electricity transmission network service providers (TNSPs). The proposal focused ensuring that the regulatory models gave effect to the AER's regulatory decisions and insures that TNSPs have a reasonable opportunity to recover their efficient costs.

2007 **Victorian Electricity Distribution Business**
Review of Smart Meter model

Reviewed the smart meter model developed by a Victorian distributor and submitted to the Victorian Essential Service Commission (ESC). The smart meter model supported the business' regulatory proposal that quantified the revenue required to meet the mandated roll out of smart meters in Victoria. The smart meter model the quantified the expected, meter, installation, communications, IT and project management costs associated with the introduction of smart meters. Further, the estimated the expected change in the business' meter reading and other ongoing costs attributed with the introduction of smart meter infrastructure.

2007 **Energy Trade Associations - APIA, ENA and Grid Australia**
Weighted Average Cost of Capital

Expert reports submitted to the Victorian Essential Services Commission evaluating its draft decision to set the equity beta at 0.7, and its methodology for determining the appropriate real risk free rate of interest, for the purpose of determining the allowed rate of return for gas distribution businesses.

2007 **Babcock and Brown Infrastructure, Qld**
Review of Regulatory Modelling

Provided advice to Babcock and Brown Infrastructure on the regulatory modelling of revenues and asset values of the Dalrymple Bay Coal Terminal (DBCT). DBCT has undertaken a substantial

capital investment to increase the capacity of the port. Brendan's role was to advise DBCT on variety of issues including the calculation of interest during construction, appropriate finance charges, cost of capital and regulatory revenues which were submitted to the Queensland Competition Authority (QCA).

2007- **ActewAGL, ACT**

Transition to National Electricity Regulation

Providing on-going advice to ActewAGL, the ACT electricity distribution network service provider, on its move to the national energy regulation. The advice covers the revenue and asset modelling, the development of a tax asset base, the new incentives for efficient operating and capital expenditure and processes for compliance, monitoring and reporting of its regulatory activities.

2007 - 2008 **Smart Meter Working Group, Ministerial Council on Energy – Assessment of the costs and benefits of a national mandated rollout of smart metering and direct load control**

Brendan was a member of NERA team that investigated the costs and benefits of a national mandated rollout of electricity smart meters. Brendan's prime responsibility was to undertake the modelling of the costs and benefits of smart metering. NERA's assignment required an assessment of smart metering functions and scenarios, and also considering the likely demand responses from consumers and impacts on vulnerable customers.

2005- **TransGrid, NSW**

Review of Regulatory Systems

Providing strategic advice to TransGrid, the NSW electricity transmission network service provider, on its current regulatory processes. The advice covers TransGrid's internal systems and processes for compliance, monitoring and reporting of its regulatory activities.

2006 **Grid Australia, National**

Submission to application by Stanwell to change the national Electricity Rules (Replacement and Reconfiguration investments)

Developed and drafted a submission to the AEMC on the appropriateness of the draft Rule change that extended the application of the regulatory test to replacement and reconfiguration investments.

2006 **Grid Australia, National**

Submission to application by MCE to change the national Electricity Rules (Regulatory Test)

Developed and drafted a submission to the AEMC on the appropriateness of the draft Rule change which changed the

Regulatory Test as it applies to investments made under the market benefits limb.

2006 **Office of the Tasmanian Energy Regulator**
Implications of the pre-tax or post-tax WACC
Provided a report to OTTER on the potential implications of changing from a pre-tax to a post-tax regulatory framework.

2006 **Babcock Brown Infrastructure**
Regulatory Modelling of Dalrymple Bay Coal Terminal
Developed the economic model used to determine revenues at Dalrymple Bay Coal Terminal. This included updating the model for capital expenditure to upgrade capacity at the terminal, account for intra-year cash flows, and the proper formulation of the weighted average cost of capital and inflation.

2006 **Queensland Competition Authority, Queensland**
Review of Regulatory Revenue Models
Advised the QCA on the financial and economic logic of its revenue building block model that projects the required revenue for the Queensland gas distribution businesses and tariffs for the next 5 years.

2006 **Envestra, South Australia**
Review of RAB Roll Forward Approach
Assisted Envestra in responding to the Essential Services Commission of South Australia's consultation paper on Envestra's 2006/07 to 2010/11 gas access proposal. This involved reviewing Envestra's RAB roll forward modelling and the Allen Consulting Group's critique thereof.

2006 **Transpower, New Zealand**
Review of Regulatory Systems
Provided assistance to Transpower, the sole electricity company in New Zealand, in responding to the New Zealand Commerce Commission's announcement of its intention to declare control of Transpower. This involved developing an expert report commenting on the Commission's methodology for analysing whether Transpower's has earned excess profits in the context of New Zealand's "threshold and control" regime.

2006 **Pacific National**
Rail industry structure and efficiency
Assisted with the development of a report which examined options for addressing issues arising in vertically-separated rail industries. This involved examining a number of case study countries including the UK, US and Canada.

2005 **Australian Energy Markets Commission, Australia**
Transmission pricing regime
Advisor to the AEMC's review of the transmission revenue and pricing rules as required by the new National Electricity Law.

2005 **Queensland Rail, Australia**
Weighted Average Cost of Capital
Provided a report for Queensland Rail on the appropriate weighted average cost of capital for its regulated below rail activities.

2004-2005 **ETSA Utilities**
Review of Regulatory Modelling
Advised ETSA Utilities on the financial and economic logic of ESCOSA's regulatory models used to determine the regulatory asset base, the weighted average cost of capital, regulatory revenues and distribution prices.

2003- 2005 **TransGrid, NSW**
Review of Regulatory Revenues
Assisted TransGrid in relation to its application to the ACCC for the forthcoming regulatory review which focused on asset valuation and roll forward, cost of capital and financial/regulatory modelling.

2004 **Prime Infrastructure, Australia**
Weighted Average Cost of Capital
Provided a report for Prime Infrastructure on the appropriate weighted average cost of capital for its regulated activities (coal shipping terminal).

2004 **PowerGas, Singapore**
Review of Transmission Tariff Model
Advised the Singaporean gas transmission network owner on the financial and economic logic of its revenue building block model that projects PowerGas' revenue requirements and tariffs for the next 5 years.

2003 **ActewAGL, ACT**
Review of Regulatory Revenues
Provided strategic advice to ActewAGL in developing cost of capital principles, asset valuation and incentive mechanisms as part of their current pricing reviews for their electricity and water businesses.

2003 **Orion Energy, New Zealand**
Threshold and Control Regime in the Electricity Sector
Provided advice and assistance in preparing submissions by Orion to the Commerce Commission, in relation to the Commission's proposed

changes to the regulatory regime for electricity lines businesses. Issues addressed included asset valuation, and the form of regulatory control.

2003 **EnergyAustralia, NSW**
Pricing Strategy Under a Price Cap
Advised EnergyAustralia on IPART's financial modelling of both regulated revenues and the weighted average price cap.

2002-03 **TransGrid, NSW,**
Advice in Relation to the Regulatory Test
Modelled the net present value of a range of investment options aimed at addressing a potential reliability issue in the Western Area of New South Wales. This work was undertaken in the context of the application of the ACCC's "regulatory test" which is intended to ensure only *efficient* investment projects are included in the regulatory asset base.

2002 **Rail Infrastructure Corporation (RIC), Australia**
Review of the Cost of Capital Model
Provided advice to RIC and assisted in drafting RIC's submission to the Australian Competition and Consumer Commission (ACCC) on the appropriate cost of capital. This included building a post-tax revenue model of RIC's revenues in the regulatory period.

2002 **PowerGrid, Singapore**
Review of Transmission Tariff Model
Advised the Singaporean electricity transmission network owner on the financial and economic logic of its revenue building block model that projects PowerGrid's revenue requirements and tariffs for the next 10 years.

2002 **EnergyAustralia, Australia**
Review of IPART's Distribution Tariff Model
Advised EnergyAustralia, a NSW distribution service provider, on the economic logic of the revenue model that projects EnergyAustralia's revenue requirements and tariffs for the 2004-2009 regulatory period.

2002 **Essential Services Commission of South Australia**
Review Model to Estimating Energy Costs
Reviewed and critiqued a model for estimating retail electricity costs for retail customers in South Australia for 2002-2003.

2002 **National Competition Council (NCC), Australia**
Exploitation of Market Power by a Gas Pipeline
Provided a report to the NCC in which we developed a number of tests for whether current transmission prices were evidence of the

exploitation of market power by a gas transmission pipeline. Also provided a separate report that applied each of the tests developed. This analysis was relied on by the NCC in determining whether to recommend the pipeline in question be subject to regulation under the Australian Gas Code.

2002 **Australian Gas and Lighting, Australia**
Report on South Australian Retail Tariffs
An independent assessment on the cost components of regulated retail tariffs in South Australia that will be used by AGL in the next review.

2002 **New Zealand Telecom, New Zealand**
Report on the application of wholesale benchmarks in NZ
A report on the application of international benchmarks of wholesale discounts to New Zealand Telecom.

2002 **ENEL, Italy**
Survey of Retailer of Last Resort in NSW
Provided research into the retailer of last resort provisions in the NSW gas sector of an international review for the Italian incumbent utility.

2002 **ENEL, Italy**
Survey of Quality of Service provisions in Victoria and South Australia
Provided research into quality of service regulation for electricity distribution businesses in Victoria and South Australia of an international review for the Italian incumbent utility.

2002 **Integral Energy, Australia**
Provided Advice on the Cost of Capital for the 2004 – 2008 Distribution Network Review
Provided analysis and strategic advice to Integral Energy on the possible methodologies that IPART may use to calculate the cost of capital in the next regulatory period.

2001 **IPART, Australia**
Minimum Standards in Regulation of Gas and Electricity Distribution
Advised the NSW regulator on the appropriate role of minimum standards in regulatory regimes and how this could be practically implemented in NSW.

2001 **TransGrid, Australia**
Advice on ACCC's Powerlink WACC decision
Provided a report critically appraising the ACCC's decision regarding Powerlink's weighted average cost of capital (WACC).

Competition Policy

2005 **Confidential, Australia**
Merger Analysis
Provided expert opinion as well as strategic guidance to the merging firms on the competitive implications of that merger.

2004 **Mallesons Stephen Jaques / Sydney Airports Corporation, Australia**
Appeal to declare under Part IIIA
Provided strategic and economic advice on aspects of Virgin Blue's appeal for the declaration of airside facilities at Sydney Airport under Part IIIA of the Trade Practices Act. This cumulated in the production of an expert witness statement by Gregory Houston.

2003 **Sydney Airports Corporation, Australia**
Application to declare under Part IIIA
Expert report to the National Competition Council in connection with the application by Virgin Blue to declare airside facilities at Sydney Airport under Part IIIA of the Trade Practices Act, and the potential impact on competition in the market for air travel to and from Sydney.

2002 - 2003 **Blake Dawson Waldron/ Qantas Airways, Australia**
Alleged predatory conduct
NERA was commissioned to provide advice in relation to potential allegations of anticompetitive behaviour. Developed a paper examining the economic theory behind predation and the way courts in various jurisdictions determine whether a firm has breached competition law.

2002 **Phillips Fox and AWB Limited**
Declaration of the Victorian Intra-State Rail Network
Advised law firm Phillips Fox (and AWB Limited) in its preparation for an appeal (in the Australian Competition Tribunal) of the Minister's decision not to declare the Victorian intra-state rail network, pursuant to Part IIIA of the Trade Practices Act. This included assisting in the preparation of testimony relating to pricing arrangements for third party access to the rail network and their likely impact on competition in related markets, including the bulk freight transportation services market.

2002 **Singapore Power International (SPI)**
Impact of acquisition of a Victorian distributor on competition
Provided analysis to a company interested in acquiring CitiPower (a Victorian electricity distribution/retail business). Including an assessment of the extent to which the acquisition of CitiPower would

lead to a 'substantial lessening of competition' in a relevant energy markets, given the company's existing Australian electricity sector assets. The NERA report was submitted to the ACCC as part of the pre-bid acquisition clearance process.

Other

1999-2000 **Australian Chamber of Commerce and Industry, Australia**
Alienation of Personal Service Income
Involved in analysing the effects of the proposed business tax reform package had on a number of industries which advocated a number of recommendations to the Federal Government. The package also included the provisions to change the definition of personal service income.

1998-2000 **Australian Chamber of Commerce and Industry, Australia**
Various economic policy issues
Provided analysis on economic trends and Government policies to business groups. This covered issues such as industrial relations reform, taxation changes, business initiatives, and fiscal and monetary settings. Also compiled ACCI surveys on business conditions and expectations.

1996 **Australian Bureau of Statistics, Australia**
Productivity Measures in the Public Health Sector
Involved in a team that reported on the current methods used to measure output in the public health sector and analysed alternative methods used internationally. This was in response to the ABS investigating the inclusion of productivity changes in the public health sector.

NERA
ECONOMIC CONSULTING

NERA Economic Consulting
Darling Park Tower 3
201 Sussex Street
Sydney NSW 2000
Tel: 61 2 8864 6500 Fax: 61 2 8864 6549
www.nera.com

NERA Australia Pty Ltd, ABN 34 092 959 665