NERA
ECONOMIC CONSULTING

Estimates of the Zero-Beta Premium

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 estimates of the zero-beta premium, that is, the difference between the expected return to a zero-beta portfolio and the risk-free rate;
- to examine whether there is evidence that the zero-beta premium has changed over time;
- to determine whether standard inference in any way misleads; and
- to respond to criticisms of the use of the Black Capital Asset Pricing Model (CAPM) made by McKenzie and Partington (2012).[1]

To estimate the zero-beta premium, we use the two-pass methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979).[2] The use of this methodology enables us to generate a time series of zero-beta premium estimates with which we can test hypotheses about the mean of the estimates and whether the mean has changed over time.

We use data on portfolios formed on past beta estimates and, separately, data on individual securities to estimate the zero-beta premium for a domestic version of the CAPM.[3]

We find that:

- estimates of the zero-beta premium differ significantly from zero; but
- estimates of the zero-beta premium do not differ significantly from values for the market risk premium (*MRP*) that the Australian Energy Regulator (AER) has in the recent past adopted.

The similarity between our estimates of the zero-beta premium and values for the *MRP* that the AER has in the recent past adopted reflects the absence, empirically, of a link between beta estimates and equity returns. This absence of a link between beta estimates and equity returns has been widely documented elsewhere using data over the last half century.
2005 President of the American Association Finance Association John Campbell and his co-

---

1 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

2 Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

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

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.

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

author Tuomo Vuolteenah, for example, summarise the empirical evidence in the following way:[4,5]

> '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.'

So the simple message conveyed by our results is that an estimate of the equity beta of a firm is not useful for determining the required return on the firm's equity. Beta estimates provide no information about whether the required return on equity for a particular firm is above or below that of the average firm. In other words, one cannot use an estimate of the equity beta of a particular firm to provide a better estimate of the required return on the firm's equity than is provided by, simply, an estimate of the required return on the market.

The CAPM requires that betas be measured relative to the market portfolio of *all* assets. We, like the AER, use as a proxy for the market portfolio a value-weighted portfolio of stocks because measuring the return to the market portfolio of all assets is difficult.[6] Thus, as we readily accept, our tests will not reveal whether the CAPM itself is true or false. Our interest here, though, is not in determining whether the CAPM itself is true but in determining whether the empirical version of the CAPM that the AER employs is useful for estimating the return required on a firm's equity.

As Eugene Fama and 2007 American Finance Association President Ken French point out the CAPM itself may well be true, but:[7]

> 'this possibility cannot be used to justify the way the CAPM is currently applied. The problem is that applications typically use the same market proxies, like the value-weight portfolio of U.S. stocks, that lead to rejections of the model in empirical tests. The contradictions of the CAPM observed when such proxies are used in tests of the model show up as bad estimates of expected returns in applications ... in short, if a market proxy does not work in tests of the CAPM, it does not work in applications.'

McKenzie and Partington (2012) in recent advice to the AER cast doubt on the empirical evidence that we and others provide. In particular, they argue that: [8]

---

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

5 For US evidence, see, for example:

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

For Australian evidence, see, for example:

Lajbcygier , P. and S. M. Wheatley, *Imputation credits and equity returns*, Economic Record, 2012, pages 476-494.

6 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.

7 Fama, E. and K. French, The Capital Asset Pricing Model: Theory and evidence, Journal of Economic Perspectives, 2004, pages 43-44.

- estimates of the zero-beta premium can, in principle, be unstable;
- thin trading can create the impression that beta estimates cannot explain the cross-section of mean returns; and
- the standard errors attached to estimates of the zero-beta premium are unreliable.

We show here that:

- the concerns that McKenzie and Partington raise about the stability of the zero-beta premium will not, in practice, arise;
- our results and the results of others are largely based on the behaviour of the returns to large firms and large firms are not thinly traded; and
- published simulation evidence and simulation evidence that we provide here indicates that the standard errors attached to estimates of the zero-beta premium are not unreliable.

Finally, we show, in addition, that:

- our results do not depend in any substantive way on the assumption that we make about the value that the market places on imputation credits distributed; and
- there is no evidence that the zero-beta premium has changed over time.

---

[8] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

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 estimates of the zero-beta premium, that is, the difference between the expected return to a zero-beta portfolio and the risk-free rate;
- to examine whether there is evidence that the zero-beta premium has changed over time;
- to determine whether standard inference in any way misleads; and
- to respond to arguments that McKenzie and Partington (2012) make against the use of the Black Capital Asset Pricing Model (CAPM). [9]

To estimate the zero-beta premium, we use:

- the two-pass methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979); [10]
- portfolios formed on past beta estimates and, separately, data on individual securities; and
- a domestic version of the CAPM. [11]

The remainder of this report is structured as follows:

- section 2 provides a brief description of the theory underlying the Sharpe-Lintner (SL) CAPM and Black CAPM;
- section 3 describes the methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979); [12]
- section 4 describes the data that we use and how we form portfolios;
- section 5 provides estimates of the zero-beta premium produced under the assumption that the market places a value of 35 cents on a one-dollar imputation credit distributed;

---

9 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

10 Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

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

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.

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

12 Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

- section 6 provides a response to arguments that McKenzie and Partington (2012) make against the use of the Black CAPM; [13] and
- section 7 offers conclusions.

In addition:

- Appendix A provides a more detailed description of the methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979); [14]
- Appendix B provides the results of simulations that examine whether standard inference misleads;
- Appendix C provides estimates of the zero-beta premium produced under the assumption that the market places no value on imputation credits distributed;
- Appendix D provides the terms of reference for this report; and
- Appendix E 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*

---

[13] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

[14] Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

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. Theory

We begin by describing the theory that underlies the SL CAPM and Black CAPM and how the two models are related.

2.1. SL CAPM

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

(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,

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:

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

where:

$E(r_j)$	=	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
$E(r_m)$	=	the mean return to the market portfolio of risky assets.

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.

A more compact statement of the SL CAPM is:

$$\mathrm{E}(z_j) = \beta_j \mathrm{E}(z_m), \tag{2}$$

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.

where:

$z_j = r_j - r_f$ = the return to asset j in excess of the risk-free rate; and

$z_m = r_m - r_f$ = the return to the market portfolio in excess of the risk-free rate.

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 uses 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. So it should be no surprise to find that the empirical version of the SL CAPM that the AER uses does not adequately describe the data.

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:[17]

> '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.[18]

---

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

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

18 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.

2.2. Black CAPM

Brennan (1971) shows that if one replaces assumption (iv) with: [19]

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

$$\mathrm{E}(r_j) - \mathrm{E}(r_z) = \beta_j[\mathrm{E}(r_m) - \mathrm{E}(r_z)], \qquad r_l < \mathrm{E}(r_z) < r_b, \tag{3}$$

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 simply as the Black CAPM. The Black CAPM can be alternatively expressed as stating that:

$$\mathrm{E}(z_j) = \gamma_0 + \beta_j[\mathrm{E}(z_m) - \gamma_0], \tag{4}$$

where:

$\gamma_0 = \mathrm{E}(r_z) - r_f$ = the return to a zero-beta portfolio in excess of the risk-free rate.

The mean of the return to the market portfolio in excess of the risk-free rate is known as the market risk premium (*MRP*). So we will label the mean return to a zero-beta portfolio in excess of the risk-free rate as the zero-beta premium.

If $\gamma_0 = 0$, the model collapses to the SL CAPM, illustrating the fact that the Black CAPM is a more general model than the SL CAPM. If $\gamma_0 > 0$, as empirically is the case, then the SL CAPM will underestimate the mean returns to low-beta assets. The Black CAPM, by construction, will neither underestimate the returns to low-beta assets nor overestimate the returns to high-beta assets.

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.[20] 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.

---

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

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

3. Methodology

In this section we provide an overview of the methodology that we use to estimate the zero-beta premium. We provide a more detailed description of the methodology in Appendix A.

3.1. Models

The Black CAPM imposes the restriction that:

$$\mathrm{E}(z_{jt}) - \beta_{jt}\mathrm{E}(z_{mt}) = (1-\beta_{jt})\gamma_{0t}, \tag{5}$$

where z_{jt} is the return on stock j in excess of the risk-free rate from month t-1 to month t, z_{mt} is the return to the market portfolio in excess of the risk-free asset, β_{jt} is the beta of stock j and γ_{0t} is the mean return on a zero-beta portfolio in excess of the risk-free rate. If one were to know the mean excess return on each stock, the mean excess return to the market portfolio and the beta of each stock, then one could extract the zero-beta premium from a plot, for a cross-section of stocks, of the error with which the SL CAPM predicts the return to a stock:

$$\mathrm{E}(z_{jt}) - \beta_{jt}\mathrm{E}(z_{mt}), \tag{6}$$

on the difference between one and the beta of the stock:

$$1-\beta_{jt} \tag{7}$$

In practice, estimating the zero-beta premium is a little more complicated because one must estimate the mean excess return on each stock, the mean excess return to the market portfolio and the beta of each stock.

3.2. Two-Pass Methodology

To estimate the zero-beta premium, we use the two-pass methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979).[21] In the first pass, for each stock j and month t least squares estimates are computed of the stock's betas relative to the various factors using data over the previous five years. In the second pass, for each month t, weighted least squares estimates are computed of the zero-beta premium γ_{0t}. With the Black CAPM, this is done by regressing an estimate of the error with which the SL CAPM predicts the return to stock j:

$$z_{jt} - \hat{\beta}_{jt} z_{mt}, \tag{8}$$

on an estimate of the difference between one and the beta of the stock:

[21] Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, Robert H. and Krishna Ramaswamy, *The effect of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

$$1-\hat{\beta}_{jt}\,, \tag{9}$$

where

$\hat{\beta}_{jt}$ = an estimate of the beta of stock j in month t computed using the previous five years' worth of data.

We follow Litzenberger and Ramaswamy and use as weights the reciprocals of estimates of the idiosyncratic risks of stocks computed using data over the previous five years. Although idiosyncratic risk plays no role in determining the cost of equity in the CAPM, estimates of the idiosyncratic risks of stocks can be used to sharpen estimates of the zero-beta premium. By using the reciprocals of estimates of the idiosyncratic risks of stocks as weights, the estimates that we produce place less reliance on stocks whose returns are volatile.

To test hypotheses about the mean over time of the zero-beta premium γ_{0t} we compare the sample mean of the time series of estimates that we produce to its standard error computed in the usual way, that is, under the assumption that the series of estimates is independently and identically distributed over time.

3.3. Bias

There are two problems with the two-pass procedure. The first problem is that since the least squares estimate of the vector of betas measures the vector with error, the second-pass estimator of the zero-beta premium γ_{0t} will be biased. There are two ways of addressing this problem and we use both ways. The first way is to place stocks into portfolios, like Fama and MacBeth (1973), so as to diversify away much of the measurement error but to do so in such a manner as to retain as much of the cross-sectional variation in beta as possible.[22] The second way is to modify the second-pass estimator, as Litzenberger and Ramaswamy (1979) do, to take into account the errors-in-variables problem.[23] We use their modified estimator with a degrees-of-freedom adjustment that Shanken (1992) suggests that one use.[24]

The second problem with the two-pass procedure is that the Fama-MacBeth method of computing standard errors does not properly take into account the measurement error associated with the beta estimates and so can misstate the precision with which the mean over time of γ_{0t} is estimated. Shanken (1992) shows that if, conditional on the return to the market in excess of the risk-free rate, excess returns are homoskedastic, Fama-MacBeth standard errors will overstate the precision with which the mean is estimated.[25, 26] He notes, though,

---

22 Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

23 Litzenberger, Robert H. and Krishna Ramaswamy, *The effect of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

24 An expression for the estimator appears in Appendix A.

Shanken, Jay, On the estimation of beta pricing models, Review of Financial Studies, 1992, pages 1-33.

25 Shanken, Jay, On the estimation of beta pricing models, Review of Financial Studies, 1992, pages 1-33.

26 If the variance of one random variable conditional on another is a constant, then the distribution of the first variable conditional on the second is said to be conditionally homoskedastic. If the variance of the first random variable

that the extent to which the standard errors overstate the precision is likely to be small. Jagannathan and Wang (1998), on the other hand, show that if, conditional on the excess return to the market, excess returns are heteroskedastic, Fama-MacBeth standard errors can understate the precision with which the mean of γ_{0t} is estimated. [27]

To examine the extent to which Fama-MacBeth standard errors misstate the precision with which the mean over time of γ_{0t} is estimated, we conduct bootstrap simulations that allow for heteroskedasticity and are calibrated to the portfolio data that we construct. The results of the simulations appear in Appendix B. The simulations indicate that the extent to which Fama-MacBeth standard errors misstate the precision with which the mean of γ_{0t} is estimated is small. For example, while the mean Fama-MacBeth standard error associated with weighted least squares estimates of the mean of γ_{0t} is 0.285 per cent per month, the standard deviation of the estimates across the 100,000 replications that we conduct is 0.288 per cent per month. So, like Kalay and Michaely (2000), in our empirical work, we use Fama-MacBeth standard errors and do not adjust the standard errors for the measurement error associated with the beta estimates. [28]

3.4. Constructing Annual Estimates

We generate time series of monthly estimates of the zero-beta premium relative to the one-month risk-free rate.

3.4.1. BHM method

To construct annual estimates of the zero-beta premium relative to the AER's preferred measure of the risk-free rate, the yield on a 10-year government bond, we do the following.

1. Each month we add the one-month risk-free rate to the estimate that we produce of the zero-beta premium relative to the one-month risk-free rate. Thus we construct a time series of monthly estimates of the zero-beta rate.

2. We construct, from this time series of monthly estimates of the zero-beta rate, a time series of annual estimates in exactly the same way that Brailsford, Handley and Maheswaran (2008) construct a time series of annual returns to the market portfolio from a time series of monthly returns. [29]

   In other words, if $\hat{\gamma}_{0t}$ denotes an estimate of the zero-beta premium for month t and r_{ft} is the month-t risk-free rate, then we compute an annual estimate of the zero-beta rate, from month t-11 to month t, as:

---

conditional on the second depends on the second random variable, then the distribution is said to be conditionally heteroskedastic. See

Hayashi, F., *Econometrics*, Princeton University Press, 2000, page 13.

[27] Jagannathan, Ravi and Zhenyu Wang, *An asymptotic theory for estimating beta-pricing models using cross-sectional regression*, Journal of Finance, 1998, pages 1285-1309.

[28] Kalay, Avner and Roni Michaely, *Dividends and taxes: A reexamination*, Financial Management, 2000, pages 55-75.

[29] 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.

$$\left(\prod_{s=1}^{12}(1+\hat{\gamma}_{0t+1-s}+r_{ft+1-s})\right)-1 \tag{10}$$

3. Like Brailsford, Handley and Maheswaran (2008), to construct an estimate of the annual premium each year, we subtract from each annual estimate of the zero-beta rate the end-of-year yield on a 10-year government bond.[30]

4. We compute an estimate of the annual zero-beta premium relative to the yield on a 10-year government bond as the mean of the time series of annual estimates that we produce.

We label this method of computing an annual premium the 'BHM method'. There are alternative estimators that one can use for the annual zero-beta premium relative to the yield on a 10-year government bond. While the properties of these alternative estimators, across all possible samples, are similar to the properties of the estimator that we use, the estimators can provide different results in any one sample.

3.4.2. CEG method

One alternative estimator of the annual zero-beta premium relative to the yield on a 10-year government bond is the estimator that CEG (2008) and Lajbcygier and Wheatley (2012) use.[31] They construct an estimate of the annual premium in the following way.

1. They produce a time series of monthly estimates of the zero-beta premium relative to the monthly yield on a 10-year government bond.

2. They compute the mean of the time series of monthly estimates. In other words, they sum up all of the monthly estimates and divide this sum by the number of monthly estimates.

3. They compound the mean of the time series of monthly estimates of the zero-beta premium over 12 months to compute an estimate of the annual premium.

   In other words, CEG (2008) and Lajbcygier and Wheatley (2012) compute an annual estimate of the zero-beta rate as:[32]

$$(1+\bar{\gamma}_0)^{12}-1\,, \tag{11}$$

   where:

   $\bar{\gamma}_0$ = the mean of the time series of monthly estimates of the zero-beta

[30] 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.

[31] CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

[32] CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

premium.

We label this method the 'CEG method'.

For the purposes of the current report, we choose not to rely on the CEG method and instead rely on the BHM method. In other words, we employ as far as is possible, the method that Brailsford, Handley and Maheswaran (2008) use. We do so because the AER relies upon their results.[33] Nevertheless, we also report estimates that use the CEG method and we compare the properties of the two methods in Appendix A.

[33] 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.

4. Data

4.1. Stocks

We extract monthly returns from January 1964 to December 2012 for individual stocks and the imputation credits that the stocks deliver from SIRCA's Share Price and Price Relative (SPPR) database. We use data from January 1964 to December 2007 to estimate betas but, as the SPPR database does not provide market capitalisations before December 1973, we do not begin to record the returns to the portfolios that we construct until January 1974. Some of our tests that use individual security data, though, employ data from before 1974. These tests use data for the largest 100 stocks listed on the Melbourne Stock Exchange at the end of 1962, 1967 and 1972. The market capitalisations for these stocks are from the *Stock Exchange official record*, the *Stock Exchange of Melbourne official record* and the *Australian Financial Review*. [34]

We exclude foreign stocks listed in Australia. Thus, for example, we exclude Kraft Foods Inc. Also, to minimise the impact of market microstructure effects, from 1974 onwards, we exclude stocks in each year that at the end of the previous year fell outside the top 500 by market capitalisation. We choose the top 500 because the All Ordinaries Index is constructed from the top 500 stocks. From the stocks remaining, we form a number of value-weighted portfolios.

First, we form a value-weighted portfolio of the 500 stocks that we select and use the portfolio as a proxy for the Australian market portfolio.

Second, we form value-weighted portfolios on the basis of past beta estimates. At the end of December each year we use data for the prior five years to estimate the betas of all stocks relative to the Australian market portfolio, dropping those that do not have a full 60 months of data. We then place the stocks into 10 portfolios on the basis of the estimates. To ensure that our results are free of selection bias, we allocate stocks to portfolios using data that predate our second-pass portfolio regressions by at least five years. So, for example, to construct portfolios for the second-pass portfolio regressions that we run for each month of 1974, we construct beta estimates using data from January 1964 to December 1968. To construct portfolios for the second-pass portfolio regressions that we run for each month of 1975, we construct beta estimates using data from January 1965 to December 1969 and so on. Thus we form portfolios in a way that is similar to the manner in which Fama and MacBeth (1973) form portfolios. [35] On the other hand, while we conduct tests that use these 10 portfolios, we also, in contrast to Fama and MacBeth, conduct tests that use individual stocks. So our results do not rely solely on the behaviour of a small number of large stocks or solely on the behaviour of a large number of small stocks. We use both portfolio and individual stock data.

---

[34] The SPPR database contains returns from 1958 to 1973 but does not provide market capitalisations over this period. To augment these data we previously collected by hand end-of-year market capitalisations for the largest 100 stocks listed on the Melbourne Stock Exchange for the years 1957, 1962, 1967 and 1972. We chose to collect the data at five-yearly intervals to limit the amount of work involved.

[35] Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

4.2. Bills and Bonds

We construct an estimate of the one-month risk-free rate before 1974 from data provided by the Reserve Bank of Australia (RBA) and we take the one-month Australian risk-free rate from 1974 onwards from the SPPR and the end-of-month yield on a 10-year Commonwealth Government Security (CGS) from the RBA.[36] Like Fama and MacBeth (1973), we estimate the zero-beta premium relative to the one-month risk-free rate using monthly data.[37] The AER, though, uses the yield on a 10-year government bond as a measure of the risk-free rate and not the return to a one-month bill. So we also compute annual estimates of the zero-beta premium relative to the yield on a 10-year government bond using the two methods that we describe in Section 3.

---

36 We use the rate on a three-month Treasury note taken from the RBA *Bulletin* or the RBA web site as an estimate for the one-month risk-free rate. There are months where the *Bulletin* does not provide a rate for a three-month note. Where the data are missing we estimate the three-month rate as the yield on a two-year note less an estimate of the spread between the yield and the rate on a three-month note. We use as an estimate of the spread, the average spread over no more than one year computed using data from, where possible, immediately before – or, otherwise, closest to the months in which data are missing.

37 Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

5. Empirical Results

We estimate the zero-beta premium under different assumptions about the value of a one dollar imputation credit distributed. In this section we assume – consistent with the recent Australian Competition Tribunal decision – that the market places a value of 35 cents on a one dollar credit distributed.[38] In Appendix C, we assume – consistent with the evidence that Lajbcygier and Wheatley (2012) provide – that the market places no value on credits distributed.[39]

5.1. Summary Statistics

To begin with, we provide, in Table 5.1, summary statistics for the 10 portfolios formed on past beta estimates. Because, like Fama and MacBeth (1973), we estimate the zero-beta premium relative to the one-month risk-free rate using monthly data, estimates of the premium on each portfolio that we report in Table 5.1 are computed relative to the one-month risk-free rate.[40] For the sake of illustration, though, we annualise the premiums by multiplying them by 12. Table 5.1 indicates that while the beta estimates of the portfolios rise monotonically in moving from portfolio 1 to portfolio 10, the annualised premiums over the one-month bill – in evidence that appears inconsistent with the SL CAPM as the AER applies it – do not exhibit the same behaviour.

Table 5.1
Summary statistics for the 10 portfolios formed on past beta estimates

Portfolio	Annualised premium over bill	β
1	11.27	0.59
2	8.95	0.63
3	7.37	0.73
4	6.05	0.81
5	7.67	0.87
6	6.33	0.93
7	4.32	1.00
8	8.06	1.12
9	4.35	1.18
10	11.88	1.32

Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Beta estimates are the value-weighted averages across time of estimates computed using the previous 60 months of data. Estimates are computed using data from 1974 to 2012.

[38] ACT, *Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9*, May 2011.

[39] Lajbcygier , P. And S. M. Wheatley, *Imputation credits and equity returns*, Economic Record, 2012, pages 476-494.

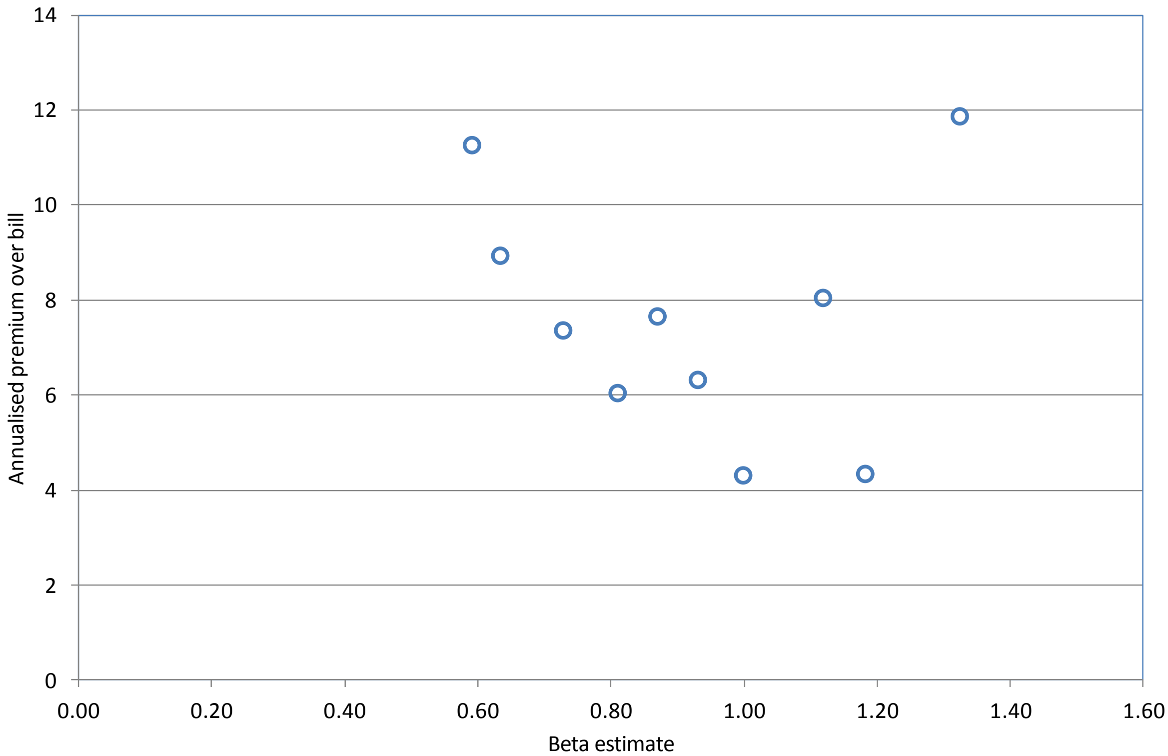
[40] Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

This evidence is shown graphically in Figure 5.1. The figure does not support the proposition that there is a positive relation between risk, measured by an estimate of beta, and return and so suggests that estimates of the zero-beta premium may come close to matching the *MRP*.[41]

5.2. Zero-Beta Estimates

Table 5.2 provides estimates of the annual zero-beta premium relative to the yield on a 10-year government bond computed using the BHM method – that is, in the same way that the AER computes estimates of the *MRP*.[42] Both portfolio and security estimates of the zero-beta premium differ significantly from zero but do not differ significantly from the values for the *MRP* of around six per cent per annum that the AER has in the recent past chosen.

Figure 5.1
Annualised premium over bill against beta estimate for 10 portfolios formed on past beta estimates



Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Estimates are computed using data from 1974 to 2012.

---

41 Note, from (4), that there will be no relation between risk, measured by beta, and return when the zero-beta premium matches the market risk premium.

42 AER, *Access arrangement final decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 2: Attachments*, March 2013, page 118.

Handley, *An estimate of the historical equity risk premium for the period 1883 to 2011*, April 2012, page 6.

The fact that estimates of the zero-beta premium do not differ significantly from the values that the AER has chosen in the recent past for the *MRP* is consistent with the evidence that Figure 5.1 provides that there is little relation across stocks between risk, measured by an estimate of beta, and return. [43]

Table 5.2
Estimates of the zero-beta premium relative to the yield on a 10-year government bond

	Portfolios	Securities
Estimate	13.95	11.05
Standard error	(5.48)	(3.39)
P-Value	[0.01]	[0.00]

Notes: Data are from the RBA and SIRCA's SPPR database. Estimates of the premium are in per cent per annum, are computed using data from 1974 to 2012 and the BHM method and are relative to the yield on a 10-year Commonwealth Government Security. P-values are for a two-sided test of the null that the zero-beta premium is zero.

5.3. Stability Tests

We also test whether there is evidence that the zero-beta premium has changed over the sample we use. Table 5.3 provides estimates of the zero-beta premium that use data over two sub-samples of approximately the same length: 1974 to 1993 and 1994 to 2012. The table provides Smith-Satterthwaite tests of the null that the zero-beta premiums in the two sub-samples are identical. The results of these tests indicate that there is no evidence against this null hypothesis although the standard errors attached to the differences between the estimates are large – signifying that the tests lack power.

5.4. Forecasts

In advice offered to the AER, Handley (2011) suggests that there may be sufficient variation through time in the zero-beta premium that estimates of the premium based on past data may be of little use going forward. [44] For example, he states that:

> 'Roll (1977 p.134) shows that for any portfolio which lies on the positively sloped segment of the efficient set (of risky assets) there exists a unique zero beta portfolio. This means that the zero-beta asset and the return thereon is sample specific (in relation to the set of assets under consideration, the particular proxy for the market portfolio and the time period under consideration). This therefore

---

43 For example, from Table 5.2, a test of the null that the zero-beta premium is six per cent per annum that uses individual security data does not reject the null at conventional levels because the p-value for a two-sided test of the null associated with the statistic

$$\frac{11.05-6.00}{3.39}=1.49$$

is 0.14.

44 Handley, J., *Peer review of draft report by Davis on the cost of equity*, January 2011, pages 14-15.

diminishes the efficacy of using previous empirical studies to estimate the expected return on the zero-beta portfolio.'

Similarly, the AER in its May 2013 *Consultation Paper* states that in past decisions: [45]

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

Table 5.3
Stability tests that use estimates of the zero-beta premium

	Portfolios			Securities		
	1974-1993	1994-2012	Difference	1974-1993	1994-2012	Difference
Estimate	17.68	10.03	7.65	12.99	9.00	4.00
Std. error	(9.78)	(4.70)	(10.85)	(5.31)	(4.25)	(6.80)
P-value	[0.09]	[0.05]	[0.49]	[0.02]	[0.05]	[0.56]

Notes: Data are from the RBA and SIRCA's SPPR database. Estimates of the zero-beta premium are computed using the BHM method and are relative to the 10-year CGS yield. P-values are for two-sided tests of the null that the zero-beta premium is zero or that the premium does not differ across sub-periods. To test the null that the zero-beta rate does not differ across the two sub-periods we use the Smith-Satterthwaite test described by Miller and Freund (1965). [46]

Miller, I. and Freund, J.E., Probability and statistics for engineers, Prentice-Hall, Englewood Cliffs, NJ, 1965.

To determine whether estimates of the zero-beta premium based on past data are of use going forward, we follow Lajbcygier and Wheatley (2012) and examine recursive estimates.[47] 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 5.2 below plots recursive estimates of the zero-beta premium computed using the largest 100 stocks from 1963 to 1973 and the largest 500 stocks from 1974 to 2012.

---

45 AER, *Consultation paper: Rate of return guidelines*, May 2013.

46 The Smith-Satterthwaite statistic for a test of the null hypothesis that the mean of a normally distributed series x matches the mean of an independently normally distributed series y is:

$$\left(\frac{s_x^2}{n_x}+\frac{s_y^2}{n_y}\right)^{-1/2}\left(\bar{x}-\bar{y}\right),$$

where $\bar{x}$ and s_x are the sample mean and sample standard deviation of a sample of n_x observations on x and where $\bar{y}$ and s_y are the sample mean and sample standard deviation of a sample of n_y observations on y. Under the null, the statistic will be approximately t-distributed with:

$$\left\lfloor\left(\frac{s_x^4}{n_x^2(n_x-1)}+\frac{s_y^4}{n_y^2(n_y-1)}\right)^{-1}\left(\frac{s_x^2}{n_x}+\frac{s_y^2}{n_y}\right)^2\right\rfloor$$

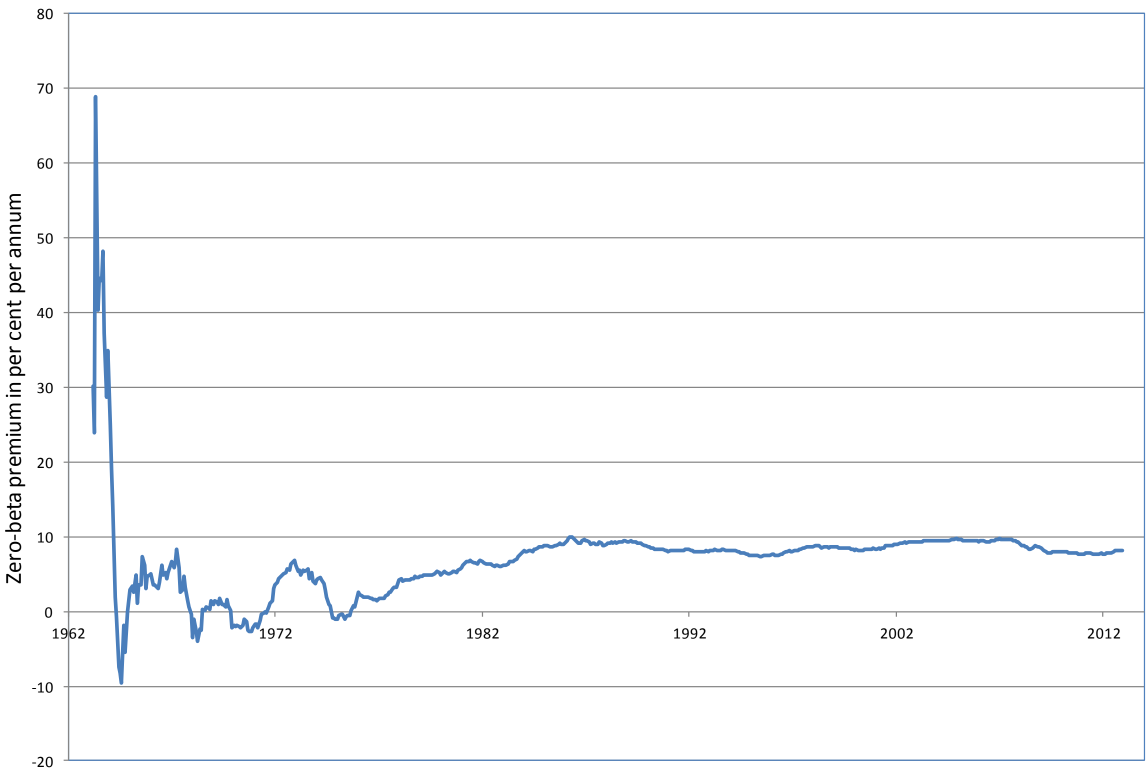
degrees of freedom, where $\lfloor . \rfloor$ is the floor function.

47 Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 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.

An interesting question is whether currently available data indicate that the SL CAPM or Black CAPM will provide a better estimate of the future zero-beta premium. To answer this question, it will be useful first to discover whether *knowing* an average of past zero-beta premiums would historically have been of use in predicting the premium. In other words, it will be useful to know whether there is so much variation in the zero-beta premium that even if one were to have known what the values of the premium had been in the past, the information would not have been of help in predicting the premium. Clark and West (2007) develop a statistic that can answer this question.[48]

Figure 5.2
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.

[48] Clark, T.E and K.D. West, *Approximately normal tests for equal predictive accuracy in nested models*, Journal of Econometrics, 2007, pages 291–311.

Clark and West (2007) note that even if a model is true, it may be that a more restrictive model that is untrue may deliver out-of-sample forecasts that have a lower mean squared error (MSE) than forecasts that use the true but less restrictive model – particularly when the forecasts are based on relatively short time series.[49] The reason for this is that the more general model will have more parameters that one must estimate than the restrictive model and so the forecasts that it generates will be less precise. If the restrictive model is sufficiently far from being correct and one generates forecasts from a sufficiently long time series, then, of course, the bias associated with forecasts generated by the more restrictive model will more than offset the loss of precision. This will be true because:

$$\mathrm{MSE} = \mathrm{Bias}^2 + \mathrm{Variance} \tag{12}$$

Clark and West develop a way of adjusting downwards the MSE associated with a more general model to reflect the increase in the MSE that will come about from having to estimate more parameters. We use their method to adjust the MSE associated with forecasts of the zero-beta premium that use the Black CAPM, which is a more general model than the SL CAPM. Clark and West also develop a test that can be used with recursive estimates to compare a general model to a more restrictive model.[50] This test can be used to determine whether *knowing* the parameters of the more general model would have enabled one historically to generate forecasts that were better, using MSE as a criterion, than forecasts generated by the more restrictive model. Clark and West also provide simulations that enable one to determine significance given a value for their test statistic.

Since the more restrictive model, the SL CAPM, constrains the zero-beta premium to be zero, the test, that Clark and West (2007) introduce, takes on a particularly simple form. Using their test to determine whether knowing an average of past zero-beta premiums would historically have been of use in predicting the zero-beta premium, amounts to testing whether the quantity:[51]

$$\frac{1}{T}\sum_{k=\tau}^{T}\hat{\gamma}_{0k+1}\left(\frac{1}{k}\sum_{t=1}^{k}\hat{\gamma}_{0t}\right), \tag{13}$$

where:

τ = the minimum number of observations used to compute an estimate of the zero-beta premium; and

$\hat{\gamma}_{0t}$ = an estimate of the zero-beta premium γ_{0t},

---

[49] Clark, T.E and K.D. West, *Approximately normal tests for equal predictive accuracy in nested models*, Journal of Econometrics, 2007, pages 291–311.

[50] Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

[51] Clark, T.E and K.D. West, *Approximately normal tests for equal predictive accuracy in nested models*, Journal of Econometrics, 2007, pages 291–311.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

is significantly different from zero. In other words, the test amounts, approximately, to asking whether an average of past estimates of the zero-beta premium is useful for forecasting future estimates of the premium.

We use monthly data and so measure the zero-beta premium relative to the one-month risk-free rate. Also, we follow Welch and Goyal (2008) and choose the minimum number of observations used to generate a forecast to be 20 years, that is, 240 months.[52] Table 5.4 below shows that with this choice the Clark-West statistic rejects at the 5 per cent level the hypothesis that knowing an average of past zero-beta premiums would not have been of use in predicting the premium.

The analysis so far, however, does not provide an answer to the question of whether *currently* available data indicate that the SL CAPM or Black CAPM will provide a better estimate of the future zero-beta premium. The Clark and West (2007) tests only indicate whether knowing an average of past premiums would have been, in the past, of use in predicting the premium.[53] To answer the question of whether currently available data indicate that the SL CAPM or Black CAPM will provide a better estimate of the future zero-beta premium, we use the estimates provided by Table 5.2.

Table 5.4
An evaluation of the Black CAPM and Sharpe-Lintner CAPM

Mean squared error			
Black CAPM (unadjusted)	Black CAPM (adjusted)	Sharpe-Lintner CAPM	Clark-West statistic
10.121	9.611	10.697	3.820*

Note: Data are from the RBA and from SIRCA's SPPR database. Mean squared errors are based on monthly returns measured in per cent.

**The Clark-West statistic indicates that one can reject the hypothesis at the 5 per cent level that knowing an average of past values of the zero-beta premium would not have been of use in predicting future values of the premium.*

Toro-Vizcarrondo and Wallace (1968) examine a framework containing a simple regression with T observations of a dependent variable on K non-stochastic independent variables.[54] Consider the restriction $\theta = \theta_0$ where θ is one of the regression's parameters. Toro-Vizcarrondo and Wallace show that, under the null that:

---

[52] Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

Welch, I. and A. Goyal, *A comprehensive look at the empirical performance of equity premium prediction*, Review of Financial Studies, 2008, pages 1455-1508.

[53] Clark, T.E and K.D. West, *Approximately normal tests for equal predictive accuracy in nested models*, Journal of Econometrics, 2007, pages 291–311.

[54] Toro-Vizcarrando, 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.

$$\mathrm{MSE}(\hat{\theta}) = \mathrm{MSE}(\theta_0), \tag{14}$$

where:

$\mathrm{MSE}(\hat{\theta})$ = the MSE associated with the unrestricted least squares estimator for θ; and

$\mathrm{MSE}(\theta_0)$ = the MSE associated with the restricted least squares estimator for θ,

the F- statistic for a test of the restriction $\theta = \theta_0$ will be F distributed with one and T-K degrees of freedom and non-centrality parameter one. This analysis implies that under the null that the SL CAPM and Black CAPM will provide equally good estimates of the future zero-beta premium, the F- statistic for a test of the restriction:

$$\frac{1}{T}\sum_{s=1}^{T}\gamma_{0t} = 0 \tag{15}$$

will be F distributed with one and T-1 degrees of freedom and non-centrality parameter one. This F-test statistic is simply:

$$\left(\frac{1}{T}\sum_{s=1}^{T}\hat{\gamma}_{0t} \Big/ s\left(\frac{1}{T}\sum_{s=1}^{T}\hat{\gamma}_{0t}\right)\right)^2, \tag{16}$$

where:

$\frac{1}{T}\sum_{s=1}^{T}\hat{\gamma}_{0t}$ = the sample mean of the estimates of the zero-beta premium; and

$s\left(\frac{1}{T}\sum_{s=1}^{T}\hat{\gamma}_{0t}\right)$ = the standard error of the sample mean.

Thus the F-test statistic is simply the square of the t-test statistic that is the ratio of the sample mean to its standard error

Table 5.5 tests the null hypothesis that the SL CAPM and Black CAPM will provide equally good estimates of the future zero-beta premium using MSE as a criterion. The portfolio estimates of the zero-beta premium are not sufficiently precise to enable one to reject the hypothesis that the SL CAPM and Black CAPM will deliver estimates that have the same MSE. The security estimates, on the other hand, are sufficiently precise that one can reject the hypothesis in favour of the alternative that the Black CAPM will deliver an estimate that will have a lower MSE than an estimate produced by the SL CAPM.

In advice provided to the AER Handley (2011) states that: [55]

[55] Handley, J., *Peer review of draft report by Davis on the cost of equity*, January 2011, page 15.

> 'It is well understood that all cost of capital estimates are subject to error. So whilst it may be argued that the Black CAPM is more "realistic" than the Sharpe CAPM, the onus is on the proponents to show that this outweighs the benefits associated with using a riskfree rate which is largely observable.'

We have responded to this challenge. Our tests show that there are benefits to using an estimate of the zero-beta rate in place of the risk-free rate.

Table 5.5
Toro-Vizcarrondo and Wallace tests of the SL CAPM versus the Black CAPM

	T-V & W test statistic	P-value
Portfolios	6.480	0.071
Securities	10.625	0.018

Note: Data are from the RBA and from SIRCA's SPPR database.

5.5. Alternative Ways of Constructing Annual Estimates

As we note in Section 3, there are alternative methods that one can use to construct an estimator for the annual zero-beta premium relative to the yield on a 10-year government bond. In section 3, we describe two methods: the BHM method that we use above and the CEG method that CEG (2008) and Lajbcygier and Wheatley (2012) employ.[56] Again, briefly, the essential difference between the two methods is that the BHM method uses the average of an annual time series whereas the CEG method uses the average of a monthly time series.

Table 5.6 provides estimates of the zero-beta premium relative to the 10-year CGS yield that use the CEG method. Not surprisingly, the estimate of the zero-beta premium for the CAPM that uses the returns to the largest 500 Australian stocks from 1974 to 2012 is similar to the estimate of 8.15 that Lajbcygier and Wheatley (2012) produce using data for these returns from 1974 to 2010.[57] The estimates are lower, on the other hand, than their counterparts in Table 5.2. As we emphasise, however, in Appendix A, while the properties of the estimator that uses the CEG method, across all possible samples, are similar to the properties of the estimator that uses the BHM method, the estimators can provide different results in any one sample.

Finally and most importantly, while there are differences between the point estimates in Table 5.6 and their counterparts in Table 5.2, both tables provide evidence against the null that the zero-beta premium relative to the yield on a 10-year government bond is zero but no

---

[56] CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

[57] Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

evidence that the zero-beta premium differs significantly from the values for the *MRP* of around six per cent per annum that the AER has in the recent past chosen.

The similarity between our estimates of the zero-beta premium and values for the *MRP* that the AER has in the recent past chosen reflects the absence, empirically, of a link between beta estimates and equity returns. This absence of a link between beta estimates and equity returns has been widely documented elsewhere using data over the last half century.

So the simple message conveyed by our results is that an estimate of the equity beta of a firm is not useful for determining the required return on the firm's equity. Beta estimates provide no information about whether the required return on equity for a particular firm is above or below that of the average firm. In other words, one cannot use an estimate of the equity beta of a particular firm to provide a better estimate of the required return on the firm's equity than is provided by, simply, an estimate of the required return on the market.

Table 5.6
Alternative estimates of the zero-beta premium relative to the yield on a 10-year government bond

	Portfolios	Securities
Estimate	11.23	8.74
Standard error	(4.09)	(2.07)
P-value	[0.01]	[0.00]

Notes: Data are from the RBA and SIRCA's SPPR database. The premium is in per cent per annum and is computed relative to the yield on a 10-year Commonwealth Government Security. Estimates are computed using the CEG method and data from 1974 to 2012. P-values are for a two-sided test of the null that each factor mean is zero.

6. McKenzie and Partington's Critique

In recent advice to the AER, McKenzie and Partington (2012) make a number of arguments against the use of the Black CAPM.[58] In this section we show that the arguments that they make are either:

- wrong;
- of no practical significance; or
- wrong and of no practical significance.

The fundamental message that we wish to convey in our report is that the data indicate that an estimate of the equity beta of a firm is not useful for determining the required return on the firm's equity. McKenzie and Partington provide no argument to contradict this message.

6.1. Overview

The SL CAPM presumes that an investor cares only about the mean and variance of the return to the portfolio that he or she holds and predicts that the only portfolio of risky assets that the investor will hold will be the market portfolio of risky assets. Investors in the model are assumed to be risk averse and so they will be willing to accept additional risk only if they receive an additional return. Beta measures the contribution of an asset to the risk of the market portfolio, measured by standard deviation of return, and so beta, in the SL CAPM, measures the risk of an individual asset. Assets that have higher betas must, in the SL CAPM, have higher mean returns.

Our evidence and the evidence that CEG (2008) and Lajbcygier and Wheatley (2012) provide indicates that there is no relation in Australian data between the mean return to a stock and an estimate of its beta.[59] Figure 5.1, for example, indicates that there is a substantial variation across the 10 portfolios that we form in estimates of their betas but no relation between these estimates and the mean returns to the portfolios.[60]

---

58 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

59 This evidence is consistent with what others have found in US data. Lewellen, Nagel and Shanken (2010), for example, find no significant relation between the mean return to a portfolio of stocks in excess of the bill rate and its beta using 25 value-weighted portfolios formed on the basis of book to market and size, 30 value-weighted industry portfolios and data from 1963 to 2004.

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

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, March 2012.

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

60 Roll (1977) emphasises that the SL CAPM predicts that the market portfolio of *all* assets must be mean-variance efficient. He also emphasises that tests of the SL CAPM that use a proxy for the market portfolio can reject the model, even when the model is true, because the proxy is poor. The issue that concerns Roll is whether evidence based on proxies for the market portfolio can be used to infer whether the SL CAPM itself is true or false. Discovering whether the model itself is really true, though, is not an issue that concerns us. The issue that concerns us is whether the

6.2. Analysis

McKenzie and Partington (2012) make a number of arguments to suggest that one should set aside the evidence that CEG (2008) and Lajbcygier and Wheatley (2012) provide.[61] The first argument that McKenzie and Partington make is that the results that CEG and Lajbcygier and Wheatley provide are not plausible because they imply that:[62]

> 'the return across shares and through time is a constant.'

This argument is not correct. The evidence that CEG and Lajbcygier and Wheatley provide indicates solely that an estimate of the beta of a stock is not useful in explaining the cross-section of mean returns – a result against which one would think that it should be difficult to argue. Their evidence and the evidence that we provide here does not imply that the return required on a stock is a constant across stocks. The return to a stock may depend on:

- the beta of a stock computed relative to the market portfolio of *all* risky assets, but CEG and Lajbcygier and Wheatley, like the AER, are unable to measure it correctly; or
- on sources of risk *other* than an exposure to the return to the market portfolio.

McKenzie and Partington (2012) also point out that estimates of the zero-beta rate can, in principle, be sensitive to the choice of a proxy for the market portfolio.[63] In particular, they illustrate this potential problem with numerical examples. The examples are based on a world in which there are three assets whose characteristics are described in Table 6.1.

---

empirical version of the SL CAPM that the AER uses produces accurate estimates of required returns. The empirical version of the SL CAPM that the AER uses employs a value-weighted portfolio of Australian stocks as a proxy for the market portfolio of all assets.

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

61 CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, March 2012.

McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

62 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 4.

63 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

Table 6.1
Numerical example from McKenzie and Partington (2012)

	A	B	C
Mean return	18.00	12.00	16.00
Standard deviation of return	20.18	17.54	28.47
Correlation of return with the return to A	1.00	0.31	0.60
Correlation of return with the return to B		1.00	0.14
Correlation of return with the return to C			1.00

Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 1.

6.2.1. Sensitivity to the choice of a proxy: Efficient portfolios

McKenzie and Partington (2012) first consider two efficient portfolios whose characteristics are described in Table 6.2 and that appear in Figure 6.1, which plots mean return against standard deviation of return. [64] Figure 6.1 also plots those portfolios that have minimum variance of return for a given mean return; these portfolios plot along the hyperbola in the figure. [65] It is evident from Figure 6.1 that portfolios 1 and 2 plot close to the global minimum-variance portfolio constructed from the three assets. The global minimum-variance portfolio is the portfolio that has least risk, measured by standard deviation of return, irrespective of mean return, among all portfolios constructed solely from risky assets.

---

64 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

65 The identity of each minimum-variance portfolio can be found by minimising:

$$\sum_{j=1}^{3}\sum_{k=1}^{3} w_j w_k \mathrm{Cov}(R_j, R_k) ,$$

subject to the constraints:

$$\sum_{j=1}^{3} w_j = 1 \qquad \text{and} \qquad \sum_{j=1}^{3} w_j \mathrm{E}(R_j) = \mathrm{E}(R_p) ,$$

where w_j is the weight of asset *j* in the portfolio, Cov(R_j, R_k) is the covariance between the return to asset *j* and the return to asset *k*, E(R_j) is the expected return to asset *j* and E(R_p) is the expected return to the portfolio. For further details, see:

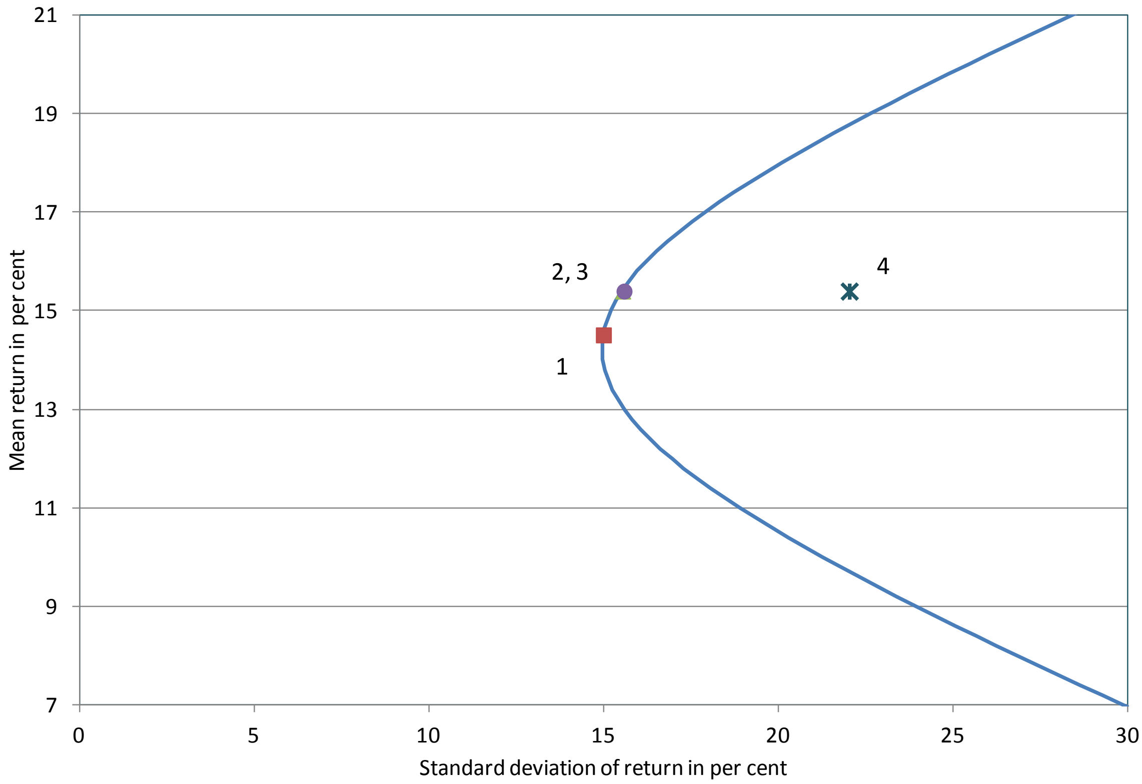
Ingersoll, J.E., *Theory of financial decision making*, Rowman and Littlefield, Lanham, Maryland, USA, 1987, pages 82-113.

Table 6.2
Characteristics of efficient portfolios 1 and 2

		Portfolio 1		Portfolio 2	
	Security mean return	Security weight	Security beta	Security weight	Security beta
A	18.00	36.43	1.05	53.73	1.16
B	12.00	55.45	0.96	41.86	0.79
C	16.00	8.11	1.02	4.41	1.04
		Portfolio mean return	Portfolio standard deviation	Portfolio mean return	Portfolio standard deviation
		14.51	15.00	15.40	15.55

Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 2.

Figure 6.1
Numerical example from McKenzie and Partington (2012)

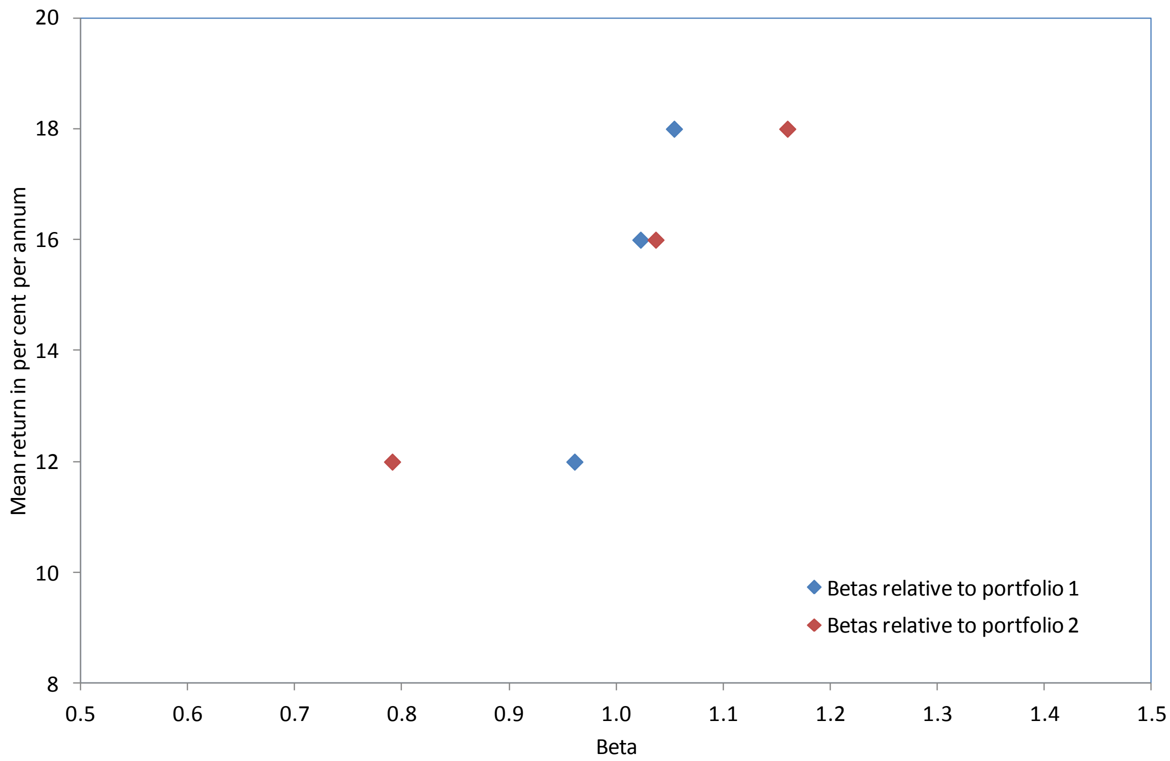


Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Tables 2 and 3.

The betas of the three assets and any portfolio constructed from the three assets will be exactly one relative to the global minimum-variance portfolio. Thus the global minimum-variance portfolio will have no zero-beta portfolio associated with it. The betas of the three assets and any portfolio constructed from the three assets will be close to one relative to any efficient portfolio that plots close to the global minimum-variance portfolio.

Figure 6.2 plots mean return against beta computed relative to portfolios 1 and 2 for the three assets A, B and C. The zero-beta rate will be the point where a line drawn through the three assets crosses the mean return axis. The example that McKenzie and Partington (2012) provide shows that if the market portfolio were an efficient portfolio and were to plot close to the global minimum-variance portfolio, then estimates of the zero-beta rate would be sensitive to a small change in the composition of the market portfolio.[66] The zero-beta rate associated with portfolio 1 is -50.04 per cent per annum while the zero-beta rate associated with portfolio 2 is -0.85 per cent per annum. The very large and negative zero-beta rate associated with portfolio 1 reflects its proximity to the global minimum-variance portfolio.

Figure 6.2
Plot of mean return against betas computed relative to portfolios 1 and 2



Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 2.

Theoretically, one would not expect an investor who was not pathologically averse to risk to be content to hold either portfolio 1 or 2. An investor holding portfolio 1 would be turning

66 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

down the opportunity of an extra mean return of 4.26 basis points for each additional basis point of risk, measured by standard deviation of return, taken on (4.26 is the slope of the hyperbola in Figure 6.1 at the point where portfolio 1 plots). An investor holding portfolio 2 would be turning down the opportunity of an extra mean return of 1.05 basis points for each additional basis point of risk taken on (1.05 is the slope of the hyperbola at the point where portfolio 1 plots). These rewards far exceed anything that is available in the market. [67]

A comparison of Figure 5.1, which uses actual data, with Figure 6.2, which uses the hypothetical data that McKenzie and Partington (2012) provide, indicates that, in practice, there is a far wider dispersion in beta than in McKenzie and Partington's hypothetical data. [68] This suggests that, in practice, the market portfolio does not plot close to the global minimum-variance portfolio. This suggestion is correct as Figure 6.3 illustrates. Figure 6.3 plots the annualised sample mean excess returns to sample minimum-variance portfolios and the market portfolio against the annualised sample standard deviations of their returns using monthly Australian data from 1974 to 2010.

Figure 6.3 indicates that not only does the market portfolio not plot close to the global minimum-variance portfolio but that – at least for the sample that consists of the largest 500 stocks listed on the Australian Stock Exchange (ASX) that Lajbcygier and Wheatley (2012) use – the global minimum-variance portfolio's Sharpe ratio exceeds the market portfolio's Sharpe ratio. [69] A portfolio's Sharpe ratio, a measure of the portfolio's performance, is the ratio of the mean return to the portfolio in excess of the risk-free rate to the standard deviation of the return to the portfolio. The Sharpe ratio of the global minimum-variance portfolio in Figure 2.5 is 0.59 while the Sharpe ratio of the market portfolio is 0.22.

A similar empirical regularity exists in US data. Jagannathan and Ma (2003) and Clarke, de Silva and Thorley (2006, 2011), for example, provide evidence that in US data the minimum-variance portfolio constructed from widely traded equities has a Sharpe ratio that exceeds the Sharpe ratio of the market portfolio. [70] The difference between the composition and performance of a minimum variance index and the composition and performance of the market portfolio has led Morgan Stanley to produce a number of minimum variance indices. [71]

---

67 Using these rewards as benchmarks would imply that were the standard deviation of the return to the market portfolio to be a relatively modest 20 per cent per annum, the *MRP* would have to be either 4.26 × 20 = 85.2 per cent per annum or 1.05 × 20 = 21 per cent per annum.

68 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

69 Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

70 Clarke, R., H. de Silva and S. Thorley, *Minimum-variance portfolios in the US equity market,* Journal of Portfolio Management, 2006, pages 10-24.

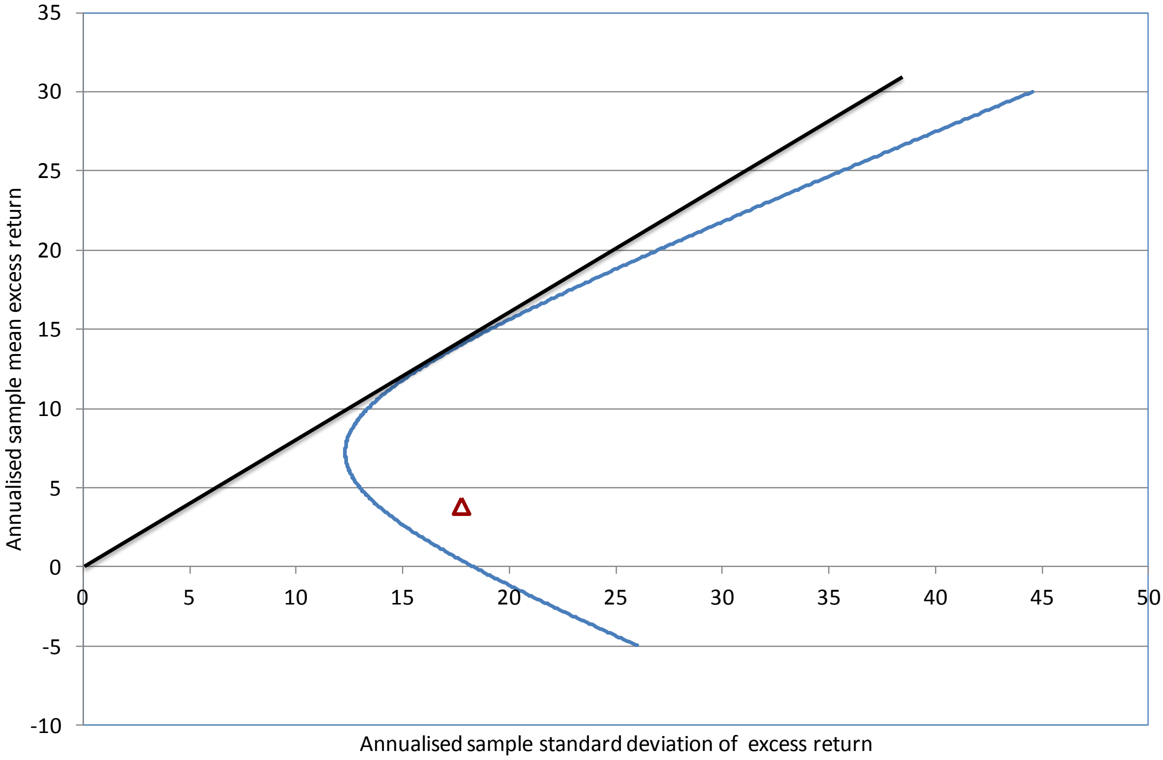
Clarke, R., H. de Silva and S. Thorley, *Minimum-variance portfolio composition,* Journal of Portfolio Management, 2011, pages 31-45.

Jagannathan, R. and T. Ma, *Risk reduction in large portfolios: Why imposing the wrong constraints helps*, Journal of Finance, 2003, pages 1651-1682.

71 http://www.msci.com/products/indices/strategy/risk_premia/minimum_volatility/

We conclude that the example that McKenzie and Partington (2012) provide to demonstrate that estimates of the zero-beta rate can, in principle, be sensitive to the choice of an efficient proxy for the market portfolio are of no practical relevance.[72] There is a body of evidence that indicates that the market portfolio plots far from the neighbourhood in mean-variance space where the issue that McKenzie and Partington raise would prove to be a problem. The potential problem that McKenzie and Partington identify would only arise if there were little variation across equities in their betas. Empirically, it is known that this is not the case.

Figure 6.3
Empirical evidence on the characteristics of the market portfolio



Source: Lajbcygier, P. and S. M. Wheatley, An evaluation of some alternative models for pricing Australian stocks, Monash University, March 2012.

Note: Data are from 1974 to 2010 and are from the RBA and from SIRCA's SPPR database. The hyperbola is the sample minimum variance set constructed from 10 portfolios formed on the basis of past beta estimates. The triangle is the market portfolio.

[72] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

6.2.2. Sensitivity to the choice of a proxy: Inefficient portfolios

McKenzie and Partington (2012) next consider two inefficient portfolios whose characteristics are described in Table 6.3 and that also appear in Figure 6.1.[73] It is evident from Figure 6.1 that portfolio 3 is close to being an efficient portfolio while portfolio 4 is far from being an efficient portfolio.

It is also evident from Table 6.3 that the composition of portfolios 3 and 4 differ substantially. For example, the weight of security A in portfolio 3 is 50 per cent but in portfolio 4 it is just 10 per cent. As another example, the weight of security C in portfolio 3 is just 10 per cent but in portfolio 4 it is 70 per cent. Not surprisingly, the beta of each security is sensitive to whether the beta is computed relative to portfolio 3 or portfolio 4. As a result, an estimate of the zero-beta rate found by drawing a line that best fits the three points in Figure 6.4, corresponding to the three securities, will depend upon what portfolio is chosen.

In practice, an estimate of the beta of a security for use in a domestic version of the SL CAPM is in general computed relative to a value-weighted index of Australian stocks. Although there are a number of different value-weighted indices of Australian stocks, their composition does not vary greatly. As a result, an estimate of the beta of a security will not in general be sensitive to the choice of an index and, consequently, an estimate of the zero-beta rate will also not be sensitive to the choice of an index. Thus this issue that McKenzie and Partington (2012) raise is also of no practical significance.

Table 6.3
Characteristics of portfolios 3 and 4

		Portfolio 3		Portfolio 4	
	Security mean return	Security weight	Security beta	Security weight	Security beta
A	18.00	50.00	1.16	10.00	0.63
B	12.00	40.00	0.76	20.00	0.25
C	16.00	10.00	1.16	70.00	1.27
		Portfolio mean return	Portfolio standard deviation	Portfolio mean return	Portfolio standard deviation
		15.40	15.59	15.40	22.04

Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 2.

A comparison of Table 6.2 and Table 6.3 shows that portfolios 2 and 3 share a similar composition, have identical mean returns and have risks, measured by standard deviation of

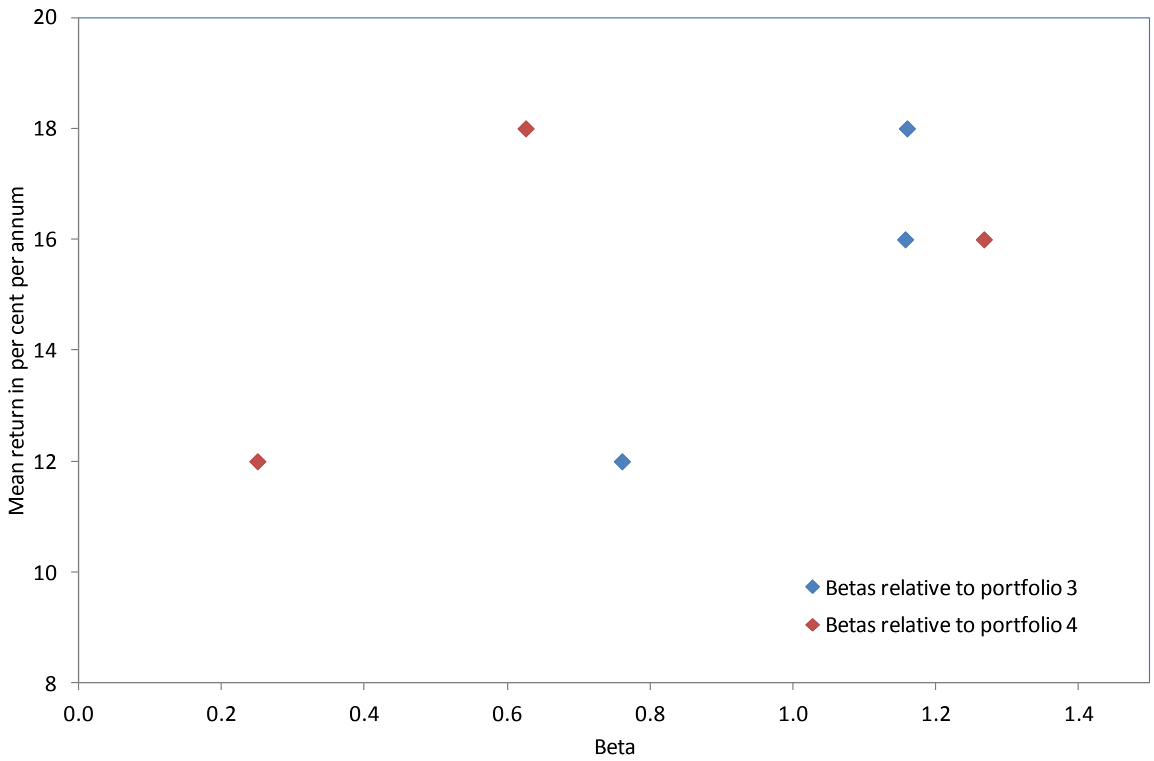
[73] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

return, that barely differ from one another. Consequently, the betas of the three individual securities should not be sensitive to the choice of portfolio 2 or 3 as an index and, in addition, an estimate of the zero-beta should not be sensitive to the choice of portfolio 2 or 3 as an index. Surprisingly, however, McKenzie and Partington (2012) state that:

> 'Despite this close similarity between the two portfolios, the relation between beta and return is very different as is evident from comparing Figure 2 and Figure 3.
>
> It is clear that in moving from Figure 2 to Figure 3 that the intercept has switched from being negative fifty percent to a positive value.'

Given the similarity between portfolios 2 and 3 this is a remarkable result. The result, in fact, is too remarkable to be true. A close inspection of McKenzie and Partington's Figure 1 and Figure 2 reveals that McKenzie and Partington's Figure 1 corresponds to portfolio 2 and their Figure 2 corresponds to portfolio 1. In other words, McKenzie and Partington have muddled up the two figures. So the comparison that McKenzie and Partington make in the quote above is not of portfolio 2 with portfolio 3, it is instead, unintentionally, of portfolio 1 with portfolio 3. Portfolios 1 and 3 have different compositions and more importantly portfolio 1, as we point out, plots close to the global minimum-variance portfolio. Consequently, the result to which they allude is neither surprising nor, again, of any practical significance.

Figure 6.4
Plot of mean return against betas computed relative to portfolios 3 and 4



Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 3.

6.2.3. Uniqueness of the zero-beta rate

If the portfolio relative to which betas are computed is a minimum-variance portfolio, but not the global minimum-variance portfolio, then there will be a unique zero-beta rate associated with the portfolio. If the portfolio relative to which betas are computed is not a minimum-variance portfolio, then, as McKenzie and Partington (2012) correctly point out, there will not be a unique zero-beta rate associated with the portfolio. [74]

Similarly, if, in a scatter plot, all points fall along a straight line, there will only be one line that one can draw through the points. If, on the other hand, all points do not fall along a straight line, there will be many different ways of drawing a line through the points. If the goal is to forecast, however, a line that best fits the data in some way will be preferred to other alternatives. Under certain conditions, ordinary least squares forecasts will be minimum variance linear unbiased forecasts and so will be at least among if not the preferred forecasts. [75] Of course, there will only be one ordinary least squares estimate of the line that best fits a scatter plot.

In practice, the use of generalised instead of ordinary least squares or the use of different sets of data can provide different estimates. How different, though, is an empirical matter. CEG use portfolios formed on the basis of past beta estimates, ordinary least squares and data from 1974 to 2007. [76] Lajbcygier and Wheatley (2012) use individual securities, the generalised least squares method of Litzenberger and Ramaswamy (1979) and Shanken (1992) and data from 1963 to 2010. [77] Here we use individual securities, portfolios formed on past beta estimates, weighted least squares, the generalised least squares method of Litzenberger and Ramaswamy and Shanken and data from 1974 to 2012. Despite the choice of a different set of assets, different regression methods and the use of different time series, the estimates of the zero-beta premium that we, CEG and Lajbcygier and Wheatley report almost uniformly differ significantly from zero at conventional levels but not from the *MRP*.

We conclude that, in practice, the issue that McKenzie and Partington (2012) raise about the non-uniqueness of the zero-beta rate attached to an inefficient portfolio is of little concern. [78] The primary aim is to determine using an estimate of the equity beta of a regulated utility what is its cost of equity. Regression is well suited to this task and produces, while not a unique set of estimates, a limited range of estimates.

---

74 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 4.

75 For the conditions see:

Greene, W.H., *Econometric analysis*, 2012, Prentice Hall, New York, NY, Chapter 4.

76 CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

77 Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, March 2012.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

Shanken, J., *On the estimation of beta pricing models*, Review of Financial Studies, 1992, pages 1-33.

78 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 4.

6.2.4. Thin trading

McKenzie and Partington (2012) state that thin trading:[79]

> 'will tend to flatten the empirically estimated relation between beta and returns, raising the intercept and reducing the slope.'

Although this statement is theoretically correct, thin trading will not be an issue for tests that use monthly data and either value-weighted portfolios or large firms. Most large firms trade not just close to the end of every month but either close to or at the end of every day. Figure 5.1 uses value-weighted portfolios of stocks and monthly data and thin trading will not have had an impact on the appearance of the graph. Thus the issue that McKenzie and Partington raise is, again, of no practical significance.

6.2.5. Standard errors

McKenzie and Partington (2012) suggest that the standard errors attached to the estimates of the zero-beta return in excess of the risk-free rate that we report in our March 2012 report may be misleading.[80] In particular, they state that:[81]

> 'although it is unclear to what extent there is a problem, it is clear that there is a question mark over the results.'

We note in our March 2012 report that:[82]

> 'the Fama-MacBeth method of computing standard errors does not properly take into account the measurement error associated with the beta estimates and so can misstate the precision with which the mean over time of the excess return to a zero-beta portfolio is estimated. Shanken (1992) shows that if, conditional on the factors, returns are homoscedastic, Fama-MacBeth standard errors will overstate the precision with which the mean is estimated. He notes, though, that for models in which the factors are portfolio returns the extent to which the standard errors overstate the precision (is) likely to be small.'

Shanken and Zhou (2007) provide simulation analysis that supports the argument that the extent to which the standard errors overstate the precision is likely to be small.[83] They examine the behaviour of estimates of the zero-beta premium computed using the procedures

---

[79] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 4.

[80] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, pages 20-22.

NERA, *The Black CAPM: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012.

[81] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 21.

[82] NERA, *The Black CAPM: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 9.

[83] Shanken, J. and G. Zhou, *Estimating and testing beta pricing models: Alternative methods and their performance in simulations*, Journal of Financial Economics, 2007, pages 40-86.

of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979).[84] Shanken and Zhou report no evidence that would suggest that the inference that we draw from our results and the results of CEG (2008) and Lajbcygier and Wheatley (2012) should be revised in any meaningful way.[85] For example, using simulations in which the returns that they generate are normally, identically and independently distributed through time, Shanken and Zhou find that a *t*-test based on an ordinary (weighted) least squares estimate of the zero-beta premium constructed using 30 years of data rejects the null that the premium is zero 5.95 (5.47) per cent of the time at the 5 per cent level when the data are constructed to satisfy the null that the zero-beta premium is zero.[86] We, CEG and Lajbcygier and Wheatley use over 30 years of data.

Shanken and Zhou (2007) also examine the impact of relaxing the assumption that returns are normally distributed through time.[87] In particular, they assume that the joint distribution of returns and the return to the market portfolio follow a multivariate *t*-distribution with eight degrees of freedom which, as they explain, means that they allow for fat tails and conditional heteroscedasticity. They find that:[88]

> 'The results are fairly robust to the assumed conditional heteroskedasticity when $T \geq 360$ (at least 30 years of data are used).'

Although Shanken and Zhou refer here to tests of hypotheses about the *MRP*, it is reasonable to assume that introducing heteroscedasticity will not have had any important impact on tests about the zero-beta premium. If introducing heteroscedasticity were to have had an impact on tests about the zero-beta premium, one would expect that Shanken and Zhou would have mentioned the fact.

McKenzie and Partington (2012) also refer to the work of Beaulieu, Dufour, Khalaf (2012) who examine the multivariate regression framework that is an alternative to the Fama and MacBeth (1973) two-pass regression approach.[89] The results that we discuss in our March

---

84 Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

85 CEG*, Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, March 2012.

86 Shanken, J. and G. Zhou, *Estimating and testing beta pricing models: Alternative methods and their performance in simulations*, Journal of Financial Economics, 2007, page 62.

87 Shanken, J. and G. Zhou, *Estimating and testing beta pricing models: Alternative methods and their performance in simulations*, Journal of Financial Economics, 2007, page 71.

88 Shanken, J. and G. Zhou, *Estimating and testing beta pricing models: Alternative methods and their performance in simulations*, Journal of Financial Economics, 2007, page 71.

89 Beaulieu, M-C., J-M Dufour and L. Khalaf, *Identification-robust estimation and testing of the zero-beta CAPM*, Review of Economic Studies, forthcoming.

Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, pages 21-22.

2012 report and that we produce here do not use this alternative method.[90] McKenzie and Partington conclude that Beaulieu, Dufour, Khalaf show that:[91]

> 'the conclusion to be drawn is clear - when it comes to estimates of the zero beta return and its standard error, caveat emptor.'

This is the wrong conclusion to draw from the work of Beaulieu, Dufour, Khalaf. Beaulieu, Dufour, Khalaf show that when simulations are calibrated to actual data, a *t*-test based on an ordinary least squares estimate of the zero-beta premium constructed using 10 (69) years of data rejects the null that the premium is zero 9.60 (5.00) per cent of the time at the 5 per cent level when the null is true.[92] We, CEG (2008) and Lajbcygier and Wheatley (2012) use over 30 years of data and so the results that Beaulieu, Dufour, Khalaf report do not suggest that the inference that we draw from our results and the results of CEG and Lajbcygier and Wheatley should be revised in any significant way.[93]

The simulation evidence that we provide in Appendix B similarly provides little evidence that one cannot rely on standard methods of inference.

6.2.6. Summary

The simple message conveyed by Figure 5.1 is that an estimate of the equity beta of a firm is not useful for determining the firm's cost of equity.[94] McKenzie and Partington (2012) argue, on the other hand, that:[95]

- estimates of the zero-beta premium can, in principle, be unstable;
- thin trading can create the impression that beta estimates cannot explain the cross-section of mean returns; and
- the standard errors attached to estimates of the zero-beta premium are unreliable.

We show here that:

---

90 NERA, *The Black CAPM: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012.

91 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012, page 22.

92 Beaulieu, Dufour, Khalaf report very different results when their simulations use the assumption that the idiosyncratic risk attached to the industry portfolios that they employ is an order of magnitude greater than one observes in the data. Using data from Ken French's web site, an estimate of the idiosyncratic risk attached to one of the 12 industry portfolios that Beaulieu, Dufour, Khalaf use is around 3 per cent per month. Beaulieu, Dufour, Khalaf assume in some of their simulations that it is, instead, 100 per cent per month. Not surprisingly, the results that they report of these simulations are unusual. Fortunately, however, the results are of only academic rather than any practical interest.

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

93 CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks*, Monash University, March 2012.

94 CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

95 McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

- the concerns that McKenzie and Partington raise about the stability of the zero-beta premium will not, in practice, arise;
- our results and the results of CEG (2008) and Lajbcygier and Wheatley (2012) are largely based on the behaviour of the returns to large firms and large firms are not thinly traded;[96] and
- published simulation evidence indicates that the standard errors attached to estimates of the zero-beta premium are not unreliable.

The fundamental message that we wish to convey in our report is that the data indicate that an estimate of the equity beta of a firm is not useful for determining the required return on the firm's equity and McKenzie and Partington's paper provides no basis to contradict this message.

---

[96] CEG, *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula*, September 2008.

Lajbcygier, P. and S. M. Wheatley, *An evaluation of some alternative models for pricing Australian stocks,* Monash University, March 2012.

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 estimates of the zero-beta premium, that is, the difference between the expected return to a zero-beta portfolio and the risk-free rate;
- to examine whether there is evidence that the zero-beta premium has changed over time;
- to determine whether standard inference in any way misleads; and
- to respond to criticisms of the use of the Black Capital Asset Pricing Model (CAPM) made by McKenzie and Partington (2012). [97]

To estimate the zero-beta premium, we use the two-pass methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979). [98] The use of this methodology enables us to generate a time series of zero-beta premium estimates with which we can test hypotheses about the mean of the estimates and whether the mean has changed over time.

We use data on portfolios formed on past beta estimates and, separately, data on individual securities to estimate the zero-beta premium for a domestic version of the CAPM. [99]

We find that:

- estimates of the zero-beta premium differ significantly from zero; but
- estimates of the zero-beta premium do not differ significantly from values for the market risk premium (*MRP*) that the Australian Energy Regulator (AER) has in the recent past adopted.

The similarity between our estimates of the zero-beta premium and values for the *MRP* that the AER has in the recent past adopted reflects the absence, empirically, of a link between beta estimates and equity returns. This absence of a link between beta estimates and equity returns has been widely documented elsewhere using data over the last half century.
2005 President of the American Association Finance Association John Campbell and his co-

---

[97] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

[98] Fama, E. F. and J. D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, R. and K. Ramaswamy, *The effects of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

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

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.

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

author Tuomo Vuolteenah, for example, summarise the empirical evidence in the following way: [100, 101]

> '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.'

So the simple message conveyed by our results is that an estimate of the equity beta of a firm is not useful for determining the required return on the firm's equity. Beta estimates provide no information about whether the required return on equity for a particular firm is above or below that of the average firm. In other words, one cannot use an estimate of the equity beta of a particular firm to provide a better estimate of the required return on the firm's equity than is provided by, simply, an estimate of the required return on the market.

The CAPM requires that betas be measured relative to the market portfolio of *all* assets. We, like the AER, use as a proxy for the market portfolio a value-weighted portfolio of stocks because measuring the return to the market portfolio of all assets is difficult. [102] Thus, as we readily accept, our tests will not reveal whether the CAPM itself is true or false. Our interest here, though, is not in determining whether the CAPM itself is true but in determining whether the empirical version of the CAPM that the AER employs is useful for estimating the return required on a firm's equity.

As Eugene Fama and 2007 American Finance Association President Ken French point out the CAPM itself may well be true, but: [103]

> 'this possibility cannot be used to justify the way the CAPM is currently applied. The problem is that applications typically use the same market proxies, like the value-weight portfolio of U.S. stocks, that lead to rejections of the model in empirical tests. The contradictions of the CAPM observed when such proxies are used in tests of the model show up as bad estimates of expected returns in applications ... in short, if a market proxy does not work in tests of the CAPM, it does not work in applications.'

McKenzie and Partington (2012) in recent advice to the AER cast doubt on the empirical evidence that we and others provide. In particular, they argue that: [104]

---

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

[101] For US evidence, see, for example:

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

For Australian evidence, see, for example:

Lajbcygier , P. and S. M. Wheatley, *Imputation credits and equity returns*, Economic Record, 2012, pages 476-494.

[102] 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.

[103] Fama, E. and K. French, The Capital Asset Pricing Model: Theory and evidence, Journal of Economic Perspectives, 2004, pages 43-44.

- estimates of the zero-beta premium can, in principle, be unstable;
- thin trading can create the impression that beta estimates cannot explain the cross-section of mean returns; and
- the standard errors attached to estimates of the zero-beta premium are unreliable.

We show here that:

- the concerns that McKenzie and Partington raise about the stability of the zero-beta premium will not, in practice, arise;
- our results and the results of others are largely based on the behaviour of the returns to large firms and large firms are not thinly traded; and
- published simulation evidence and simulation evidence that we provide here indicates that the standard errors attached to estimates of the zero-beta premium are not unreliable.

Finally, we show, in addition, that:

- our results do not depend in any substantive way on the assumption that we make about the value that the market places on imputation credits distributed; and
- there is no evidence that the zero-beta premium has changed over time.

[104] McKenzie, M. and G. Partington, *Review of NERA report on the Black CAPM*, SIRCA Limited, 24 August 2012.

Appendix A. Methodology

This appendix describes in more detail the two-pass methodology that we use to estimate the zero-beta premium.

A.1. Models

The CAPM imposes the following restriction:

$$\mathrm{E}(z_{jt} - \gamma_{0t}) = \beta_{jt}\,\mathrm{E}(z_{pt} - \gamma_{0t}), \tag{A.1}$$

where z_{jt} is the return on stock j in excess of the risk-free rate from month t-1 to month t, z_{mt} is the return to the market portfolio in excess of the risk-free rate, β_{jt} is the beta of stock j, and γ_{0t} is the mean return on a zero-beta portfolio in excess of the risk-free rate. If γ_{0t} = 0, then (A.1) collapses to the SL CAPM. If, on the other hand, γ_{1t} > 0, then (A.1) collapses to the Black CAPM.

A.2. Two-Pass Methodology

To estimate the parameters of each model, we use the two-pass methodology of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979).[105] In the first pass, for each stock j and month t least squares estimates are computed of the parameters of the time-series regression:

$$z_{jt-s} = \alpha_{jt} + \beta_{jt} z_{mt-s} + \varepsilon_{jt-s}, \qquad s = 1, 2, ..., S, \tag{A.2}$$

where α_{jt} and ε_{jt-s} are the regression intercept and disturbance. Like Litzenberger and Ramaswamy, we choose the number of months S used to compute the estimates to be 60. In the second pass, for each month t, weighted least squares estimates are computed of the parameters of the cross-sectional regression:

$$\hat{y}_{jt} = \hat{x}_{jt}\gamma_{0t} + \eta_{jt}, \qquad j = 1, 2, ..., N_t, \quad t = 1, 2, ..., T, \tag{A.3}$$

where $\hat{y}_{jt} = z_{jt} - \hat{\beta}_{jt} z_{pt}$, $\hat{x}_{jt} = 1 - \hat{\beta}_{jt}$ and $\hat{\beta}_{jt}$ is the least squares estimate of β_{jt} computed using data from t-S to t-1. The weighted least squares estimator for γ_{0t} is given by:

$$\hat{\gamma}_{0t} = \left(\sum_{j=1}^{N_t} \hat{\sigma}_{jt}^{-2}\, \hat{x}_{jt}^2 \right)^{-1} \sum_{j=1}^{N_t} \hat{\sigma}_{jt}^{-2}\, \hat{x}_{jt}\hat{y}_{jt}, \tag{A.4}$$

[105] Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

Litzenberger, Robert H. and Krishna Ramaswamy, *The effect of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

where $\hat{\sigma}_{jt}^2$ is an unbiased estimate of the variance of the regression disturbance ε_{jt-s} computed using data from months *t*-*S* through *t*-1.

A.3. Bias

Again, one of the problems with the two-pass procedure is that since the least squares estimate of the vector of betas measures the vector with error, the second-pass estimator of γ_{0t} will be biased. One of the ways of dealing with this problem is to modify the second-pass estimator, as Litzenberger and Ramaswamy (1979) do, to take into account the errors-in-variables problem.[106] The modified estimator that Shanken (1992) suggests that one use and that we use is:[107]

$$\hat{\gamma}_{0t} = \left(\sum_{j=1}^{N_t} \left(\hat{\sigma}_{jt}^{-2} \, \hat{x}_{jt}^2 - \lambda \, \hat{\sigma}_{mt}^{-2} \right) \right)^{-1} \sum_{j=1}^{N_t} \left(\hat{\sigma}_{jt}^{-2} \, \hat{x}_{jt} \hat{y}_{jt} - \lambda \, \hat{\sigma}_{mt}^{-2} \, z_{mt} \right), \qquad \text{(A.5)}$$

where $\lambda = (S-2)/((S-1)(S-4))$ and $\hat{\sigma}_{mt}^2$ is an unbiased estimate of the variance of the return to the market in excess of the risk-free rate computed using data from months *t*-*S* through *t*-1.[108]

A.4. Constructing Annual Estimates

While the methods that we use generate monthly estimates of the zero-beta premium, the regulatory process requires annual estimates. To help understand how one might use a time series of monthly returns to estimate the mean of a series of annual returns, it will be helpful to consider a simple example.

Let r_t be the return from month *t*-1 to month *t* to a single security. Also, let:

$$r_t \sim \mathrm{NID}(\mu, \sigma^2) \qquad \text{(A.6)}$$

The maximum likelihood estimator of the mean annual return to the security for a sample of monthly returns over *T* years $(r_1, r_2, ..., r_{12T})$ will be:

---

106 Litzenberger, Robert H. and Krishna Ramaswamy, *The effect of personal taxes and dividends on capital asset prices: Theory and empirical evidence*, Journal of Financial Economics, 1979, pages 163-195.

107 Shanken, Jay, *On the estimation of beta pricing models*, Review of Financial Studies, 1992, pages 1-33.

108 To see how the modification arises, note that if $\varepsilon_{jt-s} \sim \mathrm{NID}(0, \sigma_{jt}^2)$, then, conditional on the return to the market in excess of the risk-free rate, $(S-2)\hat{\sigma}_{jt}^2 / \sigma_{jt}^2 \sim \chi_{S-2}^2$, $\mathrm{E}(\hat{\sigma}_{jt}^{-2} \sigma_{jt}^2 / (S-2)) = 1/(S-4)$ and

$$\mathrm{E}(\hat{\sigma}_{jt}^{-2} \hat{x}_{jt}^2) = (S-1)\lambda \sigma_{jt}^{-2} x_{jt}^2 + \lambda \hat{\sigma}_{mt}^{-2},$$

$$\mathrm{E}(\hat{\sigma}_{jt}^{-2} \hat{x}_{jt} \hat{y}_{jt}) = (S-1)\lambda \sigma_{jt}^{-2} x_{jt} y_{jt} + \lambda \hat{\sigma}_{mt}^{-2} z_{mt}$$

For further details, see Shanken (1992).

Shanken, Jay, *On the estimation of beta pricing models*, Review of Financial Studies, 1992, pages 1-33.

$$\hat{M}_A = (1+\hat{\mu})^{12} - 1, \qquad \hat{\mu} = \frac{1}{12T}\sum_{t=1}^{12T} r_t\,, \tag{A.7}$$

where use of the delta method will show that in large samples, approximately: [109]

$$\sqrt{T}\,(\hat{M}_A - (1+\mu)^{12} + 1) \sim \mathrm{N}\left(0, 12\,(1+\mu)^{22}\sigma^2\right) \tag{A.8}$$

This estimator is based on the sample mean of the monthly returns and it will exhibit a small finite-sample bias. Using a second-order Taylor-series approximation, the bias will be approximately:

$$\frac{11(1+\mu)^{10}\sigma^2}{2T} \tag{A.9}$$

Common regulatory practice would be to estimate the mean annual return using the estimator:

$$\hat{M}_B = \frac{1}{T}\sum_{t=1}^{T}\left(\left(\prod_{s=1+12(t-1)}^{12t}(1+r_s)\right) - 1\right), \tag{A.10}$$

which has the following properties:

$$\sqrt{T}\,(\hat{M}_B - (1+\mu)^{12} + 1) \sim \mathrm{N}\left(0,\ ((1+\mu^2) + \sigma^2)^{12} - (1+\mu)^{24}\right) \tag{A.11}$$

This estimator is the sample mean of the annual returns to the security. While it is unbiased it will be less precise than the maximum likelihood estimator.

The differences between the properties of the two estimators across many samples will be very small. For example, if $T = 25$, $\mu = 1$ per cent per month and $\sigma = 5$ per cent per month, then the bias associated with the estimator based on the sample mean of the monthly returns, that is, the maximum likelihood estimator, will be just 0.06 per cent per annum, the standard deviation of the estimator will be 3.86 per cent per annum while the standard deviation of the estimator that is the sample mean of the annual returns will be 3.89 per cent per annum. Although these differences are trivial, however, estimates computed using the two estimators can differ in a meaningful way in any single sample.

The estimator that uses the BHM method resembles the second estimator that is the sample mean of the series of annual returns. The estimator that uses the CEG method resembles the first estimator that is based on the sample mean of the series of monthly returns.

---

[109] The delta method can be used to determine the distribution in large samples of a nonlinear function of an estimator. For an explanation of how the delta method works, see Hayashi (2000).

Hayashi, Fumio, *Econometrics*, Princeton University Press, 2000, pages 93-94.

Appendix B. Simulations

This appendix describes the results of bootstrap simulations that we conduct to examine the extent to which Fama-MacBeth standard errors misstate the precision with which the mean over time of the zero-beta premium γ_{0t} is estimated. We restrict our attention to tests that use the 10 portfolios that we construct on the basis of past beta estimates.

To begin with, we use least squares to estimate for each of the 10 portfolios the time series regression:

$$z_{jt} = \alpha_j + \beta_j z_{pt} + \varepsilon_{jt}, \qquad j = 1,2,...,10, \quad t = 1,2,...,T, \qquad \text{(B.1)}$$

where α_j is an intercept and ε_{jt} is a regression disturbance. We place in each row of a $T \times 11$ matrix E the vector $(z_{pt}, \hat{\varepsilon}_{1t},...,\hat{\varepsilon}_{7t})$, where $\hat{\varepsilon}_{jt}$ is a least squares residual.

We simulate data for T + 60 months using the fitted regression, random drawings with replacement from the rows of the matrix E and the restriction that $\alpha_j = 0$, j = 1, 2, ..., 10. In this way we create data that may display heteroskedasticity but are drawn from a model in which the zero-beta premium is zero.[110] We then examine the behaviour of both monthly and annual estimates of the zero-beta premium.

The monthly results of the simulations appear in Table B.1 and indicate that the extent to which Fama-MacBeth standard errors misstate the precision with which the mean over time of the zero-beta premium γ_{0t} is estimated is small.

Table B.1
Monthly simulation results: γ_0 = 0.0 per cent per month

Mean	Standard deviation	Mean standard error
0.051	0.288	0.285

Fraction in which null rejected at significance level of				
0.005	0.025	0.500	0.975	0.995
0.008	0.038	0.571	0.983	0.997

Notes: The simulations assess the behaviour of weighted least squares estimates of the monthly zero-beta premium computed relative to the one month risk-free rate that use the CAPM and the 10 portfolios formed on the basis of past beta estimates. The results are based on 100,000 replications. The mean, standard deviation and mean standard error are in per cent per month.

The annual results of the simulations appear in Table B.2 and they also indicate that the extent to which Fama-MacBeth standard errors misstate the precision with which the mean over time of the zero-beta premium is estimated is small. Again, the Fama-MacBeth standard

[110] Note that by setting $\alpha_j = 0$, j = 1, 2, ..., 10, we ensure that the simulated data satisfy the restrictions imposed by the SL CAPM. So in the simulated data the zero-beta premium is, by construction, zero.

errors are computed in the usual way, that is, under the assumption that the series of estimates are independently and identically distributed over time.

To construct annual estimates we use the time series of one-month risk-free rates and assume that the path of these rates is known in advance. Thus if r_{ft} is the month-t risk-free rate, then the risk-free rate over the year that runs from month t-11 to month t is:

$$\left(\prod_{s=1}^{12}(1+r_{ft+1-s})\right)-1 \quad \text{(B.2)}$$

Panel A of Table B.2 uses the time series of monthly estimates of the zero-beta premium to compute an estimate of the annual zero-beta premium that resembles an estimate constructed using the BHM method. In particular, in Panel A an annual estimate is formed in the following way.

1. Each month we add the one-month risk-free rate to the estimate that we produce of the zero-beta premium relative to the one-month risk-free rate. Thus we construct a time series of monthly estimates of the zero-beta rate.
2. We construct, from this time series of monthly estimates of the zero-beta rate, a time series of annual estimates in exactly the same way that Brailsford, Handley and Maheswaran (2008) construct a time series of annual returns to the market portfolio from a time series of monthly returns. [111]
3. To construct an estimate of the annual premium each year, we subtract from each annual estimate the risk-free rate for that year computed using (B.2).
4. We compute an estimate of the annual zero-beta premium as the mean of the time series of annual estimates that we produce.

Panel B of Table B.2 uses the time series of monthly estimates of the zero-beta premium to compute an estimate of the annual zero-beta premium that resembles an estimate constructed using the CEG method. This estimate of the annual premium is computed in the following way.

1. The mean of the time series of monthly zero-beta premium estimates is computed.
2. The estimate of the monthly premium is compounded over 12 months to produce an estimate of the annual premium.

Table B.2 indicates that there is little to choose between the two estimators. Both estimators are upwardly biased while the second estimator is marginally more precise. On the other hand, the fraction of the time that the null is rejected at the 0.5 per cent and 2.5 per cent levels is similar for tests that use either the estimator in Panel A or the estimator in Panel B.

---

[111] 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.

Table B.2
Annual simulation results: γ_0 = 0.0 per cent per month

Panel A: Estimates based on series of annual estimates				
Mean		Standard deviation		Mean standard error
0.656		3.768		3.705
Fraction in which null rejected at significance level of				
0.005	0.025	0.500	0.975	0.995
0.006	0.033	0.565	0.973	0.992
Panel B: Estimates based on series of monthly estimates				
Mean		Standard deviation		Mean standard error
0.663		3.474		3.445
Fraction in which null rejected at significance level of				
0.005	0.025	0.500	0.975	0.995
0.006	0.034	0.571	0.980	0.996

Notes: The simulations assess the behaviour of estimates of the annual zero-beta premium that use the CAPM and the 10 portfolios formed on the basis of past beta estimates. The results are based on 100,000 replications. The mean, standard deviation and mean standard error are in per cent per annum.

Table B.3 provides results for the two estimators for data generated under the assumption that the zero-beta premium is 0.5 per cent per month. The theoretical value of the annual zero-beta premium under this assumption is 6.627 per cent. The table indicates that there is again little to choose between the two estimators. The first estimator exhibits a small upward bias while the second estimator exhibits a small downward bias. Once more, the second is marginally more precise than the first. On the other hand, the fraction of the time that the null is rejected at the 0.5 per cent and 2.5 per cent levels is similar for tests that use the either of the two estimators.

Table B.3
Annual simulation results: γ_0 = 0.5 per cent per month

Panel A: Estimates based on series of annual estimates				
Mean		Standard deviation		Mean standard error
6.785		3.959		3.903
Fraction in which null rejected at significance level of				
0.005	0.025	0.500	0.975	0.995
0.188	0.404	0.961	1.000	1.000
Panel B: Estimates based on series of monthly estimates				
Mean		Standard deviation		Mean standard error
6.372		3.643		3.624
Fraction in which null rejected at significance level of				
0.005	0.025	0.500	0.975	0.995
0.191	0.412	0.963	1.000	1.000

Notes: The simulations assess the behaviour of estimates of the annual zero-beta premium that use the CAPM and the 10 portfolios formed on the basis of past beta estimates. The results are based on 100,000 replications. The mean, standard deviation and mean standard error are in per cent per annum.

Appendix C. Credits Assigned No Value

In this appendix we assume – consistent with the evidence that Lajbcygier and Wheatley (2012) provide – that the market places no value on credits distributed.[112] The impact of replacing the assumption that the market places a value of 35 cents on every dollar of credits distributed with the assumption that the market places no value on credits distributed has no substantive impact on the results. Estimates of the zero-beta premium do not differ significantly from values for the *MRP* that the AER in the recent past has adopted.

C.1. Summary Statistics

Table C.1 provides summary statistics for the 10 portfolios formed on past beta estimates. As in Table 5.1, while estimates of the betas of the portfolios rise monotonically in moving from portfolio 1 to portfolio 10, the annualised premiums over the one-month bill do not exhibit the same behaviour. This evidence is shown graphically in Figure C.1. The figure does not support the proposition that there is a positive relation between risk, measured by an estimate of beta, and return and so suggests that estimates of the zero-beta premium may come close to matching the *MRP*.[113]

Table C.1
Summary statistics for the 10 portfolios formed on past beta estimates

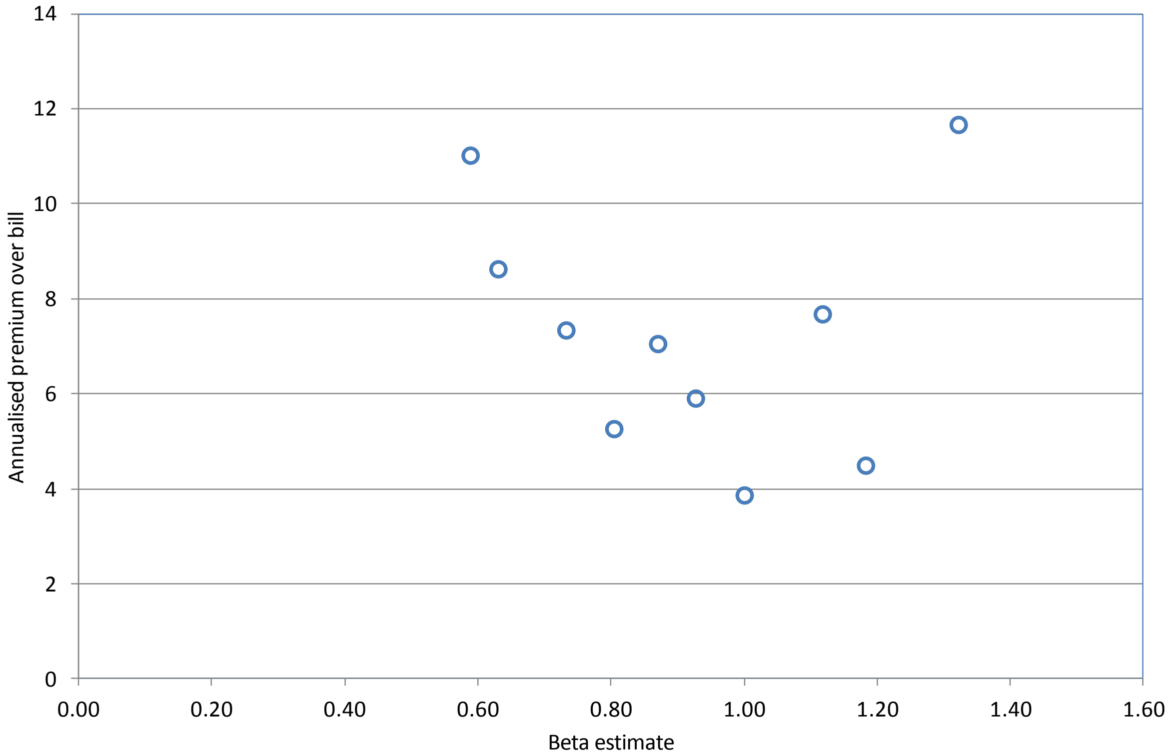
Portfolio	Annualised premium over bill	β
1	11.02	0.59
2	8.63	0.63
3	7.34	0.73
4	5.27	0.80
5	7.06	0.87
6	5.91	0.93
7	3.87	1.00
8	7.68	1.12
9	4.50	1.18
10	11.67	1.32

Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Beta estimates are the value-weighted averages across time of estimates computed using the previous 60 months of data. Estimates are computed using data from 1974 to 2012.

[112] Lajbcygier , P. And S. M. Wheatley, *Imputation credits and equity returns*, Economic Record, 2012, pages 476-494.

[113] Again, from (4), that there will be no relation between risk, measured by beta, and return when the zero-beta premium matches the market risk premium.

Figure C.1
Annualised premium over bill against beta estimate for 10 portfolios formed on past beta estimates



Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Estimates are computed using data from 1974 to 2012.

C.2. Zero-Beta Estimates

Table C.2 provides estimates of the annual zero-beta premium relative to the yield on a 10-year government bond that use the BHM method. Once more, both portfolio and security estimates of the zero-beta premium differ significantly from zero but do not differ significantly from the values for the *MRP* of around six per cent per annum that the AER has in the recent past chosen.

C.3. Stability Tests

Finally, we again test whether there is evidence that the zero-beta premium has changed over the sample we use. Table C.3 provides estimates of the zero-beta premium that use data over two sub-samples of approximately the same length: 1974 to 1993 and 1994 to 2012. The table also provides Smith-Satterthwaite tests of the null that the zero-beta premiums in the two sub-samples do not differ from one another. The table shows that there is no evidence against this null.

Table C.2
Estimates of the zero-beta premium relative to the yield on a 10-year government bond

	Portfolios	Securities
Estimate	13.22	10.56
Standard error	(5.46)	(3.40)
P-Value	[0.02]	[0.00]

Notes: Data are from the RBA and SIRCA's SPPR database. Estimates of the premium are in per cent per annum, are computed using data from 1974 to 2012 and the BHM method and are relative to the yield on a 10-year Commonwealth Government Security. P-values are for a two-sided test of the null that the zero-beta premium is zero.

Table C.3
Stability tests that use estimates of the zero-beta premium

	Portfolios			Securities		
	1974-1993	1994-2012	Difference	1974-1993	1994-2012	Difference
Estimate	17.12	9.12	8.01	12.72	8.28	4.44
Std. error	(9.75)	(4.69)	(10.82)	(5.33)	(4.22)	(6.80)
P-value	[0.10]	[0.07]	[0.47]	[0.03]	[0.07]	[0.52]

Notes: Data are from the RBA and SIRCA's SPPR database. Estimates of the zero-beta premium are computed using the BHM method and are relative to the 10-year CGS yield. P-values are for two-sided tests of the null that the zero-beta premium is zero or that the premium does not differ across sub-periods. To test the null that the zero-beta rate does not differ across the two sub-periods we use the Smith-Satterthwaite test described by Miller and Freund (1965).

Miller, I. and Freund, J.E., Probability and statistics for engineers, Prentice-Hall, Englewood Cliffs, NJ, 1965.

Appendix D. Terms of Reference

TERMS OF REFERENCE – ESTIMATED ZERO BETA PREMIUM FOR USE IN THE BLACK CAPM

Background

The Australian Energy Regulator (AER) is developing a rate of return guideline 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).

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 recently revised NER and NGR now require the AER to have regard to multiple financial models, Clause 6.5.2 of the NER states:[114]

> "*(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.*
>
> …
>
> ***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.*"

These clauses require the AER to consider all relevant financial models and therefore provide greater scope to look at cost of equity models beyond the traditionally adopted Sharpe-Lintner CAPM.

[114] Rule 87 in the NGR contains identical provisions to clauses 6.5.2 and 6A.6.2 in the NER.

As further detailed below, the Energy Network Association (ENA) would like to engage you to provide your opinion on cost of equity estimates using models other than the Sharpe-Lintner CAPM and, in particular, provide analysis and findings on the Fama-French 3 factor model, the Dividend Growth Model and the Black CAPM within the scope of the allowed rate of return objective:[115]

> "*[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 applies to the [Service Provider] in respect of the provision of [services]*."

Scope of work

The ENA requests your opinion on the application of the Black CAPM in Australia for energy regulatory purposes. Your analysis and finding should:

- Apply the Black CAPM to Australia consistent with the allowed rate of return objective;
- Examine whether there is evidence that the applicability of the Black CAPM and its parameter estimates have changed over time;
- Assess the relationship between the Black CAPM and the Sharpe-Lintner CAPM and what your findings suggest about the applicability of the Sharpe-Lintner CAPM in Australia;
- Consider different approaches to applying the Black CAPM and estimating the premium, including any theoretical restrictions on empirical estimates;
- Consider any comments raised by the AER and other regulators about the application of the Black CAPM in Australia and the estimation of the zero beta premium;
- Use robust methods and data;
- Where relevant, have regard to other Black CAPM parameter estimates developed by the ENA and its consultants.

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

- Attach these terms of reference;
- Attach the qualifications (in the form of a curriculum vitae) of the person(s) preparing the report;
- Identify any current or future potential conflicts;
- 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;[116]

---

115 NER 6.5.2(c), 6A.6.2(c) and NGR 87 (3).

116 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.

- 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 consultant is to provide a draft report outlining the estimated zero beta premium for Australia by 1 June 2013. A final report addressing any ENA comments is to be provided by 14 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;
- Identify 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 suggestions to change or modify the scope of the consultancy should be discussed and agreed with the ENA before the quotation is submitted.

Miscellaneous costs such as travel and accommodation will be reimbursed, subject to agreement by 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[117], 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[118]

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[119]

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

---

117 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].

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

119 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[120].

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[121].

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[122].

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

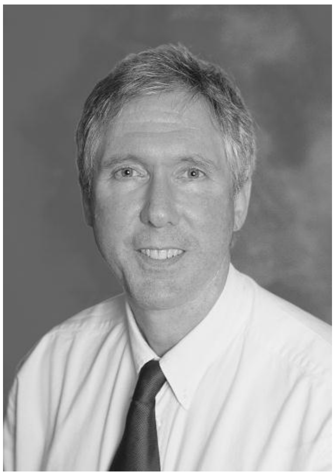
120 *Dasreef Pty Limited v Nawaf Hawchar* [2011] HCA 21.

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

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

Appendix E. 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=dea01451551935038 4275dccc6b56018&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