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The Black CAPM: Response to the ERA's Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 - 2020

A Report for DBP

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Executive Summary

DBP has asked HoustonKemp to critically review the analysis of the Economic Regulation Authority (ERA) in its December 2015 draft decision on the Dampier to Bunbury Natural Gas Pipeline, the analysis of the Australian Energy Regulator (AER) in recent decisions and the analysis of Partington and Satchell in their October 2015 report written on behalf of the AER.[1] In particular, DBP has asked that HoustonKemp critically review the analyses of the ERA, the AER and Partington and Satchell of the use of the Black Capital Asset Pricing Model (CAPM) to estimate the return required on the equity of a benchmark efficient entity.

Investors will only invest in a regulated energy utility if the return that they can expect to earn is competitive with the return that they can earn elsewhere on investments of similar risk. Clause 87 (b) of the old (prior to 28 November 2012) National Gas Rules (NGS) prescribed that in calculating an estimate of the return on equity:

> 'a well accepted financial model, such as the Capital Asset Pricing Model, is to be used.'

Clause 87 (5) of the new (from 29 November 2012 onwards) NGR does not prescribe that the SL CAPM be used to determine the return on the equity for a network service provider (NSP) but instead states that:

> 'regard must be had to: relevant estimation methods, financial models, market data and other evidence'

So under the new NGR the ERA must examine which of the pricing models that are available – of which the SL CAPM is just one – can best be used to estimate the cost of equity for an NSP.

In its December 2014 submission, DBP provides an empirical assessment of the ability of a number of models to predict returns over the period January 1979 to December 2013.[2] The models that DBP examines are:

- several versions of the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM);
- the Black CAPM; and
- the Fama-French three-factor model; and
- a naïve model that sets the return required on equity to be a constant across all equities.

The evidence that DBP provides indicates that the SL CAPM significantly underestimates the returns that will be generated by low-beta portfolios and overestimates the returns that will be generated by high-beta portfolios. The extent to which they underestimate the returns that will be generated by low-beta portfolios is both statistically and economically significant. The evidence that DBP provides, on the other hand, does not reject the hypothesis that forecasts of returns produced by the Black CAPM or a naïve model or a version of the SL CAPM designed to deliver the same estimates of the return on equity as the Black CAPM are unbiased.

[1] AER, *Preliminary decision Jemena distribution determination 2016 to 2020 Attachment 3 – Rate of return*. October 2015.

ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015.

Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015.

[2] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12.*

ERA Assessment of the Literature

The ERA, in its draft decision, states that:[3]

> 'Various studies have argued that the Black CAPM may predict a higher return on equity than the Sharpe Lintner CAPM, implying a low asset beta bias.
>
> However, following an extensive literature review, the Authority's view is that this bias is not well established in either the theoretical and empirical studies.'

We note that the ERA's assessment of the literature differs from the AER's assessment of the literature and, in particular, the assessment of the literature of the AER's advisers. The AER, for example, acknowledges that:[4]

> 'the SLCAPM has weaknesses,'

the AER's advisers, Partington and Satchell, point out that:[5]

> 'it would be fair to say that a substantial weight of academic opinion takes the evidence to be against the CAPM'

and Satchell in recent work with Muijsson and Fishwick states that:[6]

> 'One of the observations over the cross section of stocks is that the historical risk-return trade-off is flat or inverted: within the CAPM one would expect that stocks with high systemic risk would outperform their low risk counterparts, but results have shown otherwise.'

The ERA's assessment of the literature also differs from that of Nobel Prize-Winner Fama and his co-author, French. They state that: [7]

> 'The attraction of the CAPM is that it offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Unfortunately, the empirical record of the model is poor – poor enough to invalidate the way it is used in applications. The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid tests of the model. For example, the CAPM says that the risk of a stock should be measured relative to a comprehensive "market portfolio" that in principle can include not just traded financial assets, but also consumer durables, real estate and human capital. Even if we take a narrow view of the model and limit its purview to traded financial assets, is it legitimate to limit further the market portfolio to U.S. common stocks (a typical choice), or should the market be expanded to include bonds, and other financial assets, perhaps around the world? In the end, we argue that whether the model's problems reflect weaknesses in the theory or in its empirical implementation, the failure of the CAPM in empirical tests implies that most applications of the model are invalid.'

ERA Evidence

In addition to providing an assessment of the literature, the ERA provides its own evidence. The ERA produces Fama-MacBeth estimates of the zero-beta premium using:

[3] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, page 56.

[4] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 290.

[5] Partington, G. and S. Satchell, *Report to the AER: Return of (sic) equity and comment on submissions in relation to JGN*, May 2015, page 9.

[6] Muijsson, C., E. Fishwick and S. Satchell, *Taking the art out of smart beta*, University of Sydney, September 2014, page 2.

[7] Fama, E. And K. French, *The Capital Asset Pricing Model: Theory and evidence*, Journal of Economic Perspectives, Summer 2004, pages 25-26.

- five years and 20 years of data;
- five-year and 10-year CGS yields; and
- daily, weekly and monthly data.

The ERA notes that the results that it produces using daily, weekly and monthly data differ from one another and so it concludes that these results illustrate that: [8]

> 'estimates of the zero-beta return are unstable and cannot be relied on.'

These results are surprising. If betas were known and were constant through time and the number of stocks that the Fama-MacBeth estimates use were constant through time, then Fama-MacBeth estimates of the zero-beta premium, in per cent per annum, computed using daily, weekly and monthly continuously compounded returns taken from the same period would, by construction, have to be identical to one another. Under these conditions, it would make no difference whether one summed up daily Fama-MacBeth estimates to produce weekly and monthly estimates of the zero-beta premium or one summed up daily returns to produce weekly and monthly returns and then used these returns to produce weekly and monthly estimates. This analytical fact suggests that the ERA's results may be an artefact of the way in which the regulator constructs its data.

The ERA does not describe, in its DBP draft decision, what data it uses to produce its results but, in response to a request submitted by DBP, the ERA has sent the network service provider files which contain code that the regulator uses to collect data and produce results. DBP has, in turn, provided these files to us. The code indicates that the ERA uses data extracted from Bloomberg for the stocks that currently make up the S&P All Ordinaries index over periods we have not been able to identify but presume to be the last five years and last 20 years. The code also indicates that the ERA computes the returns to stocks itself from series of dividends and prices and does not rely on a single series of prices adjusted for dividends distributed.

We have examined the ERA's code and found a number of problems with the way in which the regulator assembles its data that are sufficiently serious as to cast doubt on the reliability of the ERA's results.

First, the ERA incorrectly computes the returns to stocks on the days immediately following ex-dividend days. The ERA incorrectly presumes that a purchaser of a share of stock on the ex-dividend day will pay the sum of the price at the close of business and the dividend distributed.

Second, there is no sign in the ERA's code that it takes steps to ensure that dividends and prices are denominated in the same currency. We show that when dividends and prices are denominated in different currencies that returns can be very badly mismeasured.

Third, the ERA selects stocks based on whether they are currently members of the All Ordinaries and so, because membership of the All Ordinaries is determined by market capitalisation, on their current market capitalisations. So the ERA has selected a set of stocks that are known to have performed well on average. Stocks that over the last five years or 20 years have performed well will be more likely, all else constant, than stocks that have performed badly over the last five years or 20 years to be current members of the All Ordinaries. It is likely, therefore, that the ERA's results suffer from survivorship bias.

Fourth, rather than setting the return to a stock on a day when it does not trade – or over a week or a month when it does not trade – to missing, the ERA sets the return to zero if a price has previously been recorded. Treating missing returns as zero returns can lead to estimates of the beta of a stock that are biased towards zero.

[8] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, page 40.

Fifth, in computing an estimate of the zero-beta premium, the only restriction that the ERA places on the number of observations required to compute a past estimate of beta is that there be at least two observations. Since the ERA's selection criterion guarantees that more data are missing as one works one's way back through time and because the regulator correctly records returns as missing before a price is recorded for a stock, it will be the case that some of the beta estimates on which the ERA relies will be constructed using very few observations. Estimates of beta that use few observations can be imprecise.

Issues Raised by Partington and Satchell

The AER's advisers, in an October 2015 report, raise a number of issues about the use of an alternative to the SL CAPM, the Black CAPM.

First, Partington and Satchell state about estimates of the zero-beta premium that:[9]

> 'estimates, such as those of the zero beta return, are so problematic and unreliable as to render them virtually worthless.'

In a January 2016 update of the empirical evidence on a number of pricing models – the Black CAPM among them – we use 622 monthly estimates of the zero-beta premium from March 1963 to November 2014. [10] The point that Partington and Satchell make is that there is a chance – albeit very, very small – that one of these estimates will be extremely large and negative or extremely large and positive. To examine whether any of the 622 monthly estimates that we compute fall into this category, we provide a histogram that summarises the behaviour of the data. The histogram shows that none of the estimates is either extremely large and negative or extremely large and positive.

In addition, we note that the recursive estimates of the zero-beta premium that we compute have been relatively stable for the last 30 years and do not appear to be either problematic or unreliable. The evidence that we provide in our January 2016 update suggests that the Black CAPM provides estimates of the return required on equity that are unbiased whereas the SL CAPM provides estimates that are biased. [11] This suggests that the argument that Partington and Satchell make that estimates of the zero-beta rate are 'virtually worthless' is incorrect.

Second, Partington and Satchell claim in their October 2015 report that:[12]

> 'another problem with the zero beta estimate relative to the government bond rate [is that] it is not current. The current government bond rate is readily observed, the zero beta return has to be estimated. In the case above it takes twenty years of data to do so.'

This argument ignores the fact that DBP, NERA, SFG and we use an estimate of the zero-beta rate formed by adding an estimate of the zero-beta premium to the current risk-free rate in exactly the same way that Partington and Satchell argue that one should form an estimate of the mean return to the market – by adding an historical estimate of the *MRP* to the current risk-free rate. While there may be variation in the zero-beta premium, as we believe there is in the *MRP*, the evidence that DBP provides indicates that a model that ignores any variation is nevertheless able to generate forecasts of returns that exhibit no significant bias whereas forecasts generated by the ERA's implementation of the SL CAPM exhibit a significant bias.

McKenzie and Partington refer to the work of Beaulieu, Dufour and Khalaf (2012) in an August 2012 report and, in a June 2013 report for the Energy Networks Association, NERA addresses the issues that McKenzie

[9] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 18.

[10] HoustonKemp, *The cost of equity: Response to the AER's draft decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks*, January 2016.

[11] HoustonKemp, *The cost of equity: Response to the AER's draft decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks*, January 2016.

[12] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 20.

and Partington raise.[13] Partington and Satchell raise further issues. Partington and Satchell state in their October 2015 report that: [14]

> 'we note that the paper by Beaulieu, Dufour and Khalaf (2012), reinforces our most recent discussion of technical problems in the estimation of zero beta returns.'
>
> 'Using *γ* as the notation for the return on the zero beta portfolio Beaulieu, Dufour and Khalaf observe (p3):
>
> > Identification: as βi→1, γ becomes weakly identified. Weak identification (WI) strongly affects the distributions of estimators and test statistics, leading to unreliable inference even asymptotically. This should not be taken lightly: reported betas are often close to one (see e.g. Fama and MacBeth, 1973). Further, even if estimated betas are not close to one, irregularities associated with WI are not at all precluded [in view of (1) and (2) above].
>
> Beaulieu, Dufour and Khalaf have been working on this problem for over a decade and have developed improved estimation procedures. Applying these procedures they conclude that the estimate of the zero beta return is unstable over time.'

The point that Beaulieu, Dufour and Khalaf make is that if the set of assets that one uses to estimate the zero-beta rate all have true betas that are close to one, then it will be difficult to produce reliable estimates of the rate. [15] The estimates that we produce of the zero-beta premium use the largest 100 stocks from 1963 to 1973 and the largest 500 stocks from 1974 to 2014 and it is unlikely that all of these stocks have true betas that are close to one.[16]

We note, in addition, that while Beaulieu, Dufour and Khalaf (2012) find that estimates of the zero-beta rate are unstable through time, they do not examine the stability of estimates of the zero-beta premium. Again, DBP, NERA and SFG and we compute an estimate of the zero-beta rate by adding an estimate of the zero-beta premium to the current risk-free rate and so the evidence that Beaulieu, Dufour and Khalaf provide about the instability of estimates of the zero-beta rate is of little relevance to our work and the work of DBP, NERA and SFG.

[13] Beaulieu, M-C., J-M Dufour and L. Khalaf, *Identification-robust estimation and testing of the zero-beta CAPM*, Review of Economic Studies, 2012, pages 1-33.

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

NERA, Estimates of the zero-beta premium: A report for the Energy Networks Association, June 2013, pages 35-36.

[14] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 19.

[15] Beaulieu, M-C., J-M Dufour and L. Khalaf, *Identification-robust estimation and testing of the zero-beta CAPM*, Review of Economic Studies, 2012, pages 1-33.

[16] It is likely that many stocks will have betas that are less than one and many stocks will have betas that exceed one because of differences among firms in operating leverage and the type of product or service that the firms deliver.

1. Introduction

DBP has asked HoustonKemp to critically review the analysis of the Economic Regulation Authority (ERA) in its December 2015 draft decision on the Dampier to Bunbury Natural Gas Pipeline, the analysis of the Australian Energy Regulator (AER) in recent decisions and the analysis of Partington and Satchell in their October 2015 report written on behalf of the AER.[17] In particular, DBP has asked that HoustonKemp critically review the analyses of the ERA, the AER and Partington and Satchell of the use of the Black Capital Asset Pricing Model (CAPM) to estimate the return required on the equity of a benchmark efficient entity.[18]

In particular, DBP has asked HoustonKemp to:

(a) determine whether the ERA's conclusion that estimates of the return on equity that are based on the Black CAPM can be deemed 'unreliable' is correct;

(b) determine whether the ERA's own estimates of the zero-beta premium can be deemed reliable; and

(c) respond to any other issues raised by the ERA, the AER and Partingon and Satchell.

The rest of the report is organised as follows:

- section 2 reviews the evidence that the ERA and others provide about the cross-sectional relation between returns and estimates of beta and about the zero-beta premium; and
- section 3 responds to issues that the AER, ERA and their advisers raise about estimates of the zero-beta premium and the use of the Black CAPM.

In addition:

- Appendix A1 provides details of the methodology that the ERA uses to estimate the zero-beta premium;
- Appendix A2 provides an analysis of the relation that one would expect to exist between estimate of the zero-beta premium that use daily, weekly and monthly data;
- Appendix A3 provides the terms of reference for this report;
- Appendix A4 provides a copy of the Federal Court of Australia's *Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia*; and
- Appendix A5 provides the curriculum vitae of the author of the report.

[17] AER, *Preliminary decision Jemena distribution determination 2016 to 2020 Attachment 3 – Rate of return*, October 2015.

ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015.

Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015.

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

Statement of Credentials

This report has been prepared by **Simon Wheatley**.

Simon Wheatley is a Special Adviser to HoustonKemp 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.

In preparing this report, the author (herein after referred to as 'I' or 'my' or 'me') confirms that I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance that I regard as relevant have, to my knowledge, been withheld from this report. I acknowledge that I 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*. I have been provided with a copy of the Federal Court of Australia's *Practice Note CM 7, Expert Witnesses in Proceedings in the Federal Court of Australia*, dated 4 June 2013, and my report has been prepared in accordance with those guidelines.

I have undertaken consultancy assignments for DBP in the past. However, I remain at arm's length, and as an independent consultant. Within the last three years, besides undertaking consultancy assignments for DBP, I have undertaken assignments for ActewAGL Distribution, Ausgrid, AusNet Services, Australian Gas Networks, APA, CitiPower, Endeavour Energy, the Energy Networks Association, Energex, Ergon Energy, Essential Energy, Jemena Electricity Networks, Jemena Gas Networks, Powercor, SA Power Networks, Sydney Water and United Energy. Assignments for the Energy Networks Association and these other companies have provided 85 per cent of my gross income.

2. Empirical Evidence

Investors will only invest in a regulated energy utility if the return that they can expect to earn is competitive with the return that they can earn elsewhere on investments of similar risk. The focus of this report is on whether one can use the Black CAPM to deliver an appropriate estimate of the return that investors expect to earn on equity. In this section, we examine the empirical evidence. In particular, we examine evidence provided by:

- the ERA; and
- recent evidence provided by CEG, SFG and finance academics in high-quality journals.

Clause 87 (b) of the old (prior to 28 November 2012) National Gas Rules (NGS) prescribed that in calculating an estimate of the return on equity:

> 'a well accepted financial model, such as the Capital Asset Pricing Model, is to be used.'

Clause 87 (5) of the new (from 29 November 2012 onwards) NGR does not prescribe that the SL CAPM be used to determine the return on the equity for a network service provider (NSP) but instead states that:

> 'regard must be had to: relevant estimation methods, financial models, market data and other evidence'

So under the new NGR the ERA must examine which of the pricing models that are available – of which the SL CAPM is just one – can best be used to estimate the cost of equity for an NSP.

In its December 2014 submission, DBP provides an empirical assessment of the ability of a number of models to predict returns over the period January 1979 to December 2013. [19] The models that DBP examines are:

- several versions of the SL CAPM;
- the Black CAPM; and
- the Fama-French three-factor model; and
- a naïve model that sets the return required on equity to be a constant across all equities.

[19] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12.*

The SL CAPM and the Black CAPM have been widely used by finance academics over the last 50 years. It has been known for well over 40 years, however, that there is empirical evidence against the SL CAPM.[20] Mehrling (2005), for example, reports that:[21]

> '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.'

These early results have been confirmed in many, more recent studies. For this reason, finance academics use the SL CAPM primarily as a teaching device – because of its simplicity – rather than in research. The Black CAPM was widely used in research until the early 1980s, when it was discovered that it, like the SL CAPM, tends to misprice low-cap and value stocks. This discovery subsequently led to the development by Nobel Price-winner Fama and his co-author French of a three-factor model that does not exhibit such a tendency. [22]

A naïve model that sets the return required on equity to be a constant across all equities resembles the model originally prescribed by the National Electricity Rules (NER) for transmission NSPs. The NER originally prescribed that the equity beta of a transmission business be set to one. Constraining the beta of every equity to be one will result in a return required on equity that is a constant across all equities. A pricing model should at least be able to outperform, empirically, a naïve model of this kind.

Using 10 portfolios formed on the basis of past estimates of beta and monthly data from January 1979 to December 2013, DBP (2014) finds: [23]

- statistically significant evidence of a bias attached to the forecasts generated by several versions of the SL CAPM;
- little evidence of any bias attached to the forecasts generated by the Black CAPM or forecasts generated by a version of the SL CAPM designed to deliver the same forecasts of the return on equity as the Black CAPM;
- little evidence of any bias attached to the forecasts generated by the Fama-French three-factor model; and
- little evidence of any bias attached to the forecasts generated by a naïve model.

[20] 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. The empirical version of the model that the ERA and others use measures the risk of an asset relative to a portfolio of stocks alone. Stocks have readily available and transparent prices relative to other risky assets such as debt, property and human capital. Stocks, though, make up a relatively small fraction of all risky assets, so the return to a portfolio of stocks need not track closely the return to the market portfolio of *all* risky assets. Thus the empirical version of the SL CAPM that the ERA actually employs differs from the theoretical model proposed by Sharpe and Lintner. The empirical version of the model that the ERA employs does resemble, though, the version that academic work tests.

Roll (1977) emphasises that difficulties in measuring the return to the market portfolio of *all* risky assets mean that it is not possible to test the SL CAPM. One may be able to reject an empirical version of the model that uses the market portfolio of stocks as a proxy for the market portfolio of all risky assets, but this rejection will not imply that the theoretical model itself is wrong. The issue that concerns us, though, is not whether the SL CAPM itself is correct, but whether the empirical version of the SL CAPM applied by the ERA works.

Since our interest is in whether the empirical version of the SL CAPM applied by the ERA works and not in whether the SL CAPM itself is true, all references to the SL CAPM in the report will be to the empirical version of the model that the ERA uses unless stated otherwise.

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

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

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

[23] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12*.

The evidence that DBP provides indicates that the SL CAPM significantly underestimates the returns that will be generated by low-beta portfolios and overestimates the returns that will be generated by high-beta portfolios. The extent to which they underestimate the returns that will be generated by low-beta portfolios is both statistically and economically significant. [24]

The ERA, in its draft decision, argues that the evidence against the SL CAPM is sensitive to whether one uses daily, weekly or monthly returns to test the model and produces its own results that appear to support this argument. We show below, however, that there are a number of problems with the way in which the regulator assembles its data and that these problems cast doubt on the reliability of the ERA's results.

The ERA, in its draft decision, also states that:[25]

> 'Various studies have argued that the Black CAPM may predict a higher return on equity than the Sharpe Lintner CAPM, implying a low asset beta bias.
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> However, following an extensive literature review, the Authority's view is that this bias is not well established in either the theoretical and empirical studies.'

We note that the ERA's assessment of the literature differs from the AER's assessment of the literature and, in particular, the assessment of the literature of the AER's advisers. The AER, for example, acknowledges that:[26]

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the AER's advisers, Partington and Satchell, point out that:[27]

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The ERA's assessment of the literature also differs from that of Nobel Prize-Winner Fama and his co-author, French. They state that: [29]

> 'The attraction of the CAPM is that it offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Unfortunately, the empirical record of the model is poor – poor enough to invalidate the way it is used in applications. The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid tests of the model. For example, the CAPM says that the risk of a stock should be measured relative to a comprehensive "market portfolio" that in principle can include not just traded financial assets, but also consumer durables, real estate and human capital. Even if we take a narrow view of the model and limit its purview to traded financial assets, is it legitimate to limit further

[24] We update the results of DBP in a January 2016 report and, not surprisingly, finds similar results.

HoustonKemp, *The cost of equity: Response to the AER's draft decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks*, January 2016.

[25] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, page 56.

[26] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 290.

[27] Partington, G. and S. Satchell, *Report to the AER: Return of (sic) equity and comment on submissions in relation to JGN*, May 2015, page 9.

[28] Muijsson, C., E. Fishwick and S. Satchell, *Taking the art out of smart beta*, University of Sydney, September 2014, page 2.

[29] Fama, E. And K. French, *The Capital Asset Pricing Model: Theory and evidence*, Journal of Economic Perspectives, Summer 2004, pages 25-26.

> the market portfolio to U.S. common stocks (a typical choice), or should the market be expanded to include bonds, and other financial assets, perhaps around the world? In the end, we argue that whether the model's problems reflect weaknesses in the theory or in its empirical implementation, the failure of the CAPM in empirical tests implies that most applications of the model are invalid.'

In what follows, we briefly review recent evidence provided by CEG, SFG and finance academics in high-quality journals.

2.1 Importance of Estimates of the Cost of Equity

While both regulated and unregulated firms use pricing models to construct estimates of the return required on equity, the costs of choosing a model that delivers a poor estimate of the return will in general be far greater for a regulated firm than for an unregulated firm. As Grout (1995) makes clear:[30, 31]

> 'For non-regulated activity prices are not directly dependent o(n) the cost of capital. Firms aim to maximize profit and the precise value of the cost of capital, since it is used as a hurdle rate, will only affect the marginal projects. If the cost of capital is mistakenly set too high then some marginal projects that are good are rejected and if it is too low then some bad projects are accepted. However, almost all will be unaffected by the exact value that is attached to the cost of capital. In contrast, for regulated activities almost all regulated prices will be affected by the cost of capital. If the cost of capital is over-estimated then the price of all these activities will be set too high, and if it is under-estimated then all prices will be too low. Obviously, the relationship will be stronger and more direct for rate of return regulation than for price cap regulation, but the general principle holds good. *The economic implications of errors in the cost of capital are far greater in the regulated sector than in the private non-regulated sector and, not surprisingly, the pressure to provide precise estimates is greater both from the regulators and those within the regulated industries than in the private non-regulated sector.*'
>
> [The emphasis is ours]

A poor estimate for the return required on equity will affect all of a regulated firm's activities while a poor estimate for the return will affect only the projects that an unregulated firm may or may not undertake that are marginal. It is important, therefore, that in computing an estimate of the return required on equity the ERA not use a model that, empirically, delivers biased estimates.

2.2 ERA Evidence

The ERA, in its draft decision, provides its own set of estimates of the zero-beta premium.[32] The ERA produces estimates of the zero-beta premium using:

- five years and 20 years of data;
- five-year and 10-year CGS yields; and
- daily, weekly and monthly data.

[30] Grout, P., *The cost of capital in regulated industries*, in M. Bishop, J. Kay and C. Mayer (eds.), The regulatory challenge, Oxford University Press, 1995, pages 386-407.

[31] It is obvious that here Grout intends a 'precise estimate' to be an accurate estimate rather than solely an estimate to which is attached a low standard error.

The Oxford Dictionary definition of precision is 'accuracy or exactness'. In statistics the precision of a random variable is the reciprocal of its variance. So in statistics a precise estimator can be exact but inaccurate.

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

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

[32] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, pages 180-188.

The ERA notes that the results that it produces using daily, weekly and monthly data differ from one another and so it concludes that these results illustrate that: [33]

> 'estimates of the zero-beta return are unstable and cannot be relied on.'

2.2.1 Method

To estimate the zero-beta premium, the ERA follows NERA (2013) and uses the returns to a sample of individual stocks and the two-pass methodology of Fama and MacBeth (1973) as modified by Litzenberger and Ramaswamy (1979) and Shanken (1992). [34] Appendix A1 describes this methodology in some detail.

2.2.2 Data

While the ERA is clear about which methodology it uses, it is not clear about what data it employs. In its DBP draft decision, the ERA does not explain:

- from where it extracts data; nor
- which stocks it uses; nor
- which sample periods it uses.

In response to a request submitted by DBP, however, the ERA has sent the network service provider two files, extract_bloomberg_price_data .r and support_functions .r, which contain code that the ERA uses to collect data and produce results. DBP has, in turn, provided these programs to us. The programs indicate that the ERA uses data extracted from Bloomberg for the stocks that currently make up the S&P All Ordinaries index over periods we have not been able to identify but presume to be the last five years and last 20 years. The programs also indicate that the ERA constructs with-dividend returns from separate series of dividends and prices. While DBP (2014), NERA (2013), Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979) use not continuously compounded returns, the ERA uses continuously compounded returns. [35] The ERA does not make any adjustment for a value that the market may attach to imputation credits distributed.

2.2.3 Results

Table 1 provides the estimates of the zero-beta premium that the ERA reports in Table 25 of Appendix 4 of its DBP draft decision. The table shows that the estimates depend on whether they are based on 5 or 20 years of data. This not surprising because estimates of the zero-beta premium that use short time series are imprecise and so one would expect the estimates to differ from one another. More disconcerting, however, is the observation that the ERA's estimates also appear to depend on whether they are based on daily, weekly or monthly data. These results are surprising. If betas were known and were constant through time and the number of stocks that the Fama-MacBeth estimates use were constant through time, then Fama-MacBeth estimates of the zero-beta premium, in per cent per annum, computed using daily, weekly and monthly continuously compounded returns taken from the same period would, by construction, have to be identical to

[33] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, page 40.

[34] 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.

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

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

[35] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 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.

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

one another. We show this to be the case in Appendix A2. Under these conditions, it would make no difference whether one summed up daily Fama-MacBeth estimates to produce weekly and monthly estimates of the zero-beta premium or one summed up daily returns to produce weekly and monthly returns and then used these returns to produce weekly and monthly estimates. This analytical fact suggests that the ERA's results may be an artefact of the way in which the regulator constructs its data. In what follows we examine in some detail how the regulator computes returns and we identify a number of problems that are sufficiently serious as to cast doubt on the reliability of the ERA's results.

Table 1: ERA Estimates of the Zero-Beta Premium that use Daily, Weekly and Monthly Data

Frequency	CGS yield	Zero-beta premium	Frequency	CGS yield	Zero-beta premium
Panel A: 5 years of data			Panel B: 20 years of data		
Daily	5-year	7.41	Daily	5-year	6.15
Daily	10-year	7.72	Daily	10-year	6.19
Weekly	5-year	3.16	Weekly	5-year	1.93
Weekly	10-year	3.07	Weekly	10-year	1.92
Monthly	5-year	0.99	Monthly	5-year	4.32
Monthly	10-year	1.19	Monthly	10-year	4.78

Notes: Zero-beta premium estimates are annualised and in per cent.

Source: ERA, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return, December 2015, page 185.

2.2.4 Problems

The first problem with the way in which the ERA computes returns has to do with how the regulator handles the impact of dividends. Inspection of the ERA's code reveals that the ERA computes the continuously compounded return to stock *j* on the day it goes ex-dividend, *t*, as:

$$\ln\left(\frac{P_{jt}+D_{jt}}{P_{jt-1}}\right) \quad (1)$$

where:

P_{jt} = the price of stock *j* on day *t*;

D_{jt} = the dividend to be paid by stock *j*.

Thus the ERA computes the continuously compounded return to the stock on the day that it goes ex-dividend correctly. Inspection of the ERA's code also reveals, however, that the regulator computes the continuously compounded return to stock *j* on the day after it goes ex-dividend, $t+1$, as:

$$\ln\left(\frac{P_{jt+1}}{P_{jt}+D_{jt}}\right) \quad (2)$$

So the ERA computes the continuously compounded return to the stock on the day after it goes ex-dividend incorrectly. An investor purchasing the stock at the close of business on the day that the stock goes ex-dividend will pay P_{jt} and not $P_{jt} + D_{jt}$.

The continuously compounded return to stock *j* on the day after it goes ex-dividend, $t+1$, should be:

$$\ln\left(\frac{P_{jt+1}}{P_{jt}}\right), \quad (3)$$

where we assume that the stock does not go ex-dividend on two consecutive days.

To understand what impact this error will have on the data, it will be helpful to consider a few examples. Table 2 below shows the continuously compounded returns to three stocks that are current members of the All Ordinaries – the Commonwealth Bank (CBA), Telstra (TLS) and the ANZ Bank (ANZ) – on their three most recent ex-dividend days, at the time of writing, and the days immediately following computed correctly and computed using the program that the ERA employs. The returns to the three stocks computed using the program that the ERA employs were provided to us by DBP. The table shows that the formula used by the ERA underestimates the returns to the three stocks on the days immediately following the three ex-dividend days because the formula assumes that investors must pay more for the stock at the close of business on the ex-dividend day than they actually pay.

Table 2: Examples of the Error Made by the ERA in Computing Returns around Ex-Dividend Days

Stock	Date	Dividend	Price	Correctly computed return	ERA return
CBA	17/08/2105	81.27			
CBA	18/08/2015	76.91	2.220	-2.67	-2.67
CBA	19/08/2015	78.27		1.75	-1.09
TLS	24/08/2015	5.88			
TLS	25/08/2015	5.83	0.155	1.77	1.77
TLS	26/08/2015	5.86		0.51	-2.11
ANZ	5/11/2015	26.65			
ANZ	6/11/2015	25.97	0.950	1.01	1.01
ANZ	9/11/2015	25.36		-2.38	-5.97

Notes: Dividends and prices are in dollars. The returns are continuously compounded and are in per cent.

Source: ERA returns computed using code supplied by the ERA and data from Bloomberg and provided to HoustonKemp by DBP.

A second problem – at least in the data that were provided to us by DBP, which were downloaded from Bloomberg using the code supplied by the ERA – is that dividends and prices are sometimes denominated in different currencies. We do not know whether the ERA took steps to eliminate any currency mismatch but we do not see any such steps in the code that the ERA supplied to DBP.

To understand how badly a return can be mismeasured when a dividend denominated in one currency is combined with prices denominated in another currency, it will be helpful to consider another example. Anglogold Ashanti (AGG) is headquartered in Johannesburg, South Africa, and is listed on five exchanges –

the ASX among them. [36] AGG is listed on the ASX as a Chess Depositary Interest (CDI) and is a current member of the All Ordinaries. [37] In the data provided to us by DBP – which were downloaded from Bloomberg using the code supplied by the ERA – the dividends that AGG pays on each CDI listed on the ASX are denominated in South African cents while the price of a CDI is in Australian dollars.

On 6 November 2012, AGG declared a dividend of 10 South African cents (0.10 South African rand) per CDI and set a currency conversion date of 22 November 2012 and an ex-dividend date of 26 November 2012. [38] On 22 November 2012 one rand sold on the spot market for 10.77 Australian cents. Thus the dividend to be paid on one CDI was set to 1.077 Australian cents, gross of South African withholding tax. The price of one CDI on Friday, 23 November 2012 was 5.90 Australian dollars and on Monday, 26 November 2012, the ex-dividend day, also 5.90 Australian dollars. Thus the correctly computed continuously compounded return on the ex-dividend day, 26 November 2012, in per cent, is:

$$100 \times \ln\left(\frac{5.90 + 0.01077}{5.90}\right) = 0.18 \quad (4)$$

In contrast, the continuously compounded return on the ex-dividend day, in per cent, contained in the files sent to us by DBP – which, again, were constructed using the code sent to DBP by the ERA – is:

$$100 \times \ln\left(\frac{5.90 + 10}{5.90}\right) = 99.14 \quad (5)$$

The substantial difference between the correctly computed return and the return constructed using the code provided by the ERA is due to the latter return treating a dividend of 10 South African cents as though it were a dividend of 10 Australian dollars – rather than 1.077 Australian cents.

Since the ERA computes the return to a stock on the day following an ex-dividend day incorrectly, any mismatch between the currency in which a dividend that a stock delivers is denominated and the currency in which the stock's price is denominated can also create a substantial difference between the correctly computed return on the day and the return constructed using the code provided by the ERA. On 27 November 2012, the day after AGG went ex-dividend, the price of a CDI was AUD 5.91. Thus the correctly computed continuously compounded return on 27 November 2012, the day after the ex-dividend day, in per cent, is:

$$100 \times \ln\left(\frac{5.91}{5.90}\right) = 0.17 \quad (6)$$

In contrast, the continuously compounded return on 27 November 2012, in per cent, contained in the files sent to us by DBP – which, again, were constructed using the code sent to DBP by the ERA – is:

$$100 \times \ln\left(\frac{5.91}{5.90 + 10}\right) = -98.97 \quad (7)$$

The substantial difference between the correctly measured return on the day after the ex-dividend day and the return constructed using the code provided by the ERA is due to:

- the incorrect assumption made by the ERA that the purchase price of a CDI at the close of business on the ex-dividend day is the sum of the dividend that the CDI delivers and its price; and

[36] http://www.anglogoldashanti.com/en/Pages/default.aspx.

[37] CDIs enable Investors to hold and transfer their interests in foreign financial products electronically via the Clearing House Electronic Sub register System (CHESS), which they would be unable to do if they held the financial products directly. See: http://www.asx.com.au/documents/settlement/CHESS_Depositary_Interests.pdf

[38] http://www.anglogoldashanti.com/en/Investors/Documents/Dividendhistory2013.pdf.

- treating a dividend of 10 South African cents as though it were a dividend of 10 Australian dollars – rather than 1.077 Australian cents.

To reiterate, we do not know whether the ERA took steps to eliminate any currency mismatch but we do not see any such steps in the code that the ERA supplied to DBP.

A third problem with the data that the ERA uses is that the ERA selects stocks based on whether they are currently members of the All Ordinaries and so, because membership of the All Ordinaries is determined by market capitalisation, on their current market capitalisations. The ERA has selected a set of stocks that are known to have performed well on average. Stocks that over the last five years or 20 years have performed well will be more likely, all else constant, than stocks that have performed badly over the last five years or 20 years to be current members of the All Ordinaries. It is likely, therefore, that the ERA's results suffer from survivorship bias.

Again, in its draft decision, the ERA does not describe what data it uses in producing estimates of the zero-beta premium. So the regulator makes no reference in its decision to the survivorship bias that can arise from selecting a sample based indirectly on current market capitalisations. The code that the ERA supplied to DBP, however, shows that the regulator is aware of the problem. Part of the code support_functions.r reads:

```
'# function 6: combines ticker ids, index, era bounds and ticker matrix to form eras ...
## sourced from https://github.com/pgarnry/RbbgExtension/
## ideally install RbbgExtension, but rJava failed on this machine
##  see R_config.txt for install details.
#' Get historical index tickers to avoid surviourship bias'
```

Thus the ERA is aware that selecting stocks based on whether they are currently members of the All Ordinaries can induce a survivorship bias. We see no evidence from the code that the ERA supplied to DBP, though, that anything was done about the problem. The routines contained in the code that are supposed to address the problem by going back to identify members of the All Ordinaries at dates in the past do not appear to have been used.

A fourth problem with the way in which the ERA computes returns has to do with how it computes returns on days when a stock does not trade. Rather than setting the return to a stock on a day when it does not trade – or over a week or a month when it does not trade – to missing, the ERA sets the return to zero if a price has previously been recorded. Treating missing returns as zero returns can lead to estimates of the beta of a stock that are biased towards zero.

Campbell, Lo and MacKinlay (1997) provide a framework in which each period stock *j* has a probability π_j of not trading and in which returns are set to zero in periods over which a stock does not trade.[39] In this framework, the beta of stock *j* computed using observed returns is:[40]

$$\left(1-\pi_j\right)\beta_j, \qquad (8)$$

where:

β_j = the beta of stock *j* computed using true, unobservable returns or what Campbell,

[39]Campbell, J.Y., A.W. Lo and A.C. MacKinlay, *The econometrics of financial markets*, Princeton University Press, 1997, pages 84-99.

[40]See Exercise 3.2 in Campbell, Lo and MacKinlay's text and its solution in the manual of Adamek, Campbell, Lo, MacKinlay and Viceira (1997).

Adamek, P., J. Campbell, A. Lo, A. MacKinlay and L. Viceira, *A solution manual to the econometrics of financial markets*, Princeton University Press, 1997.

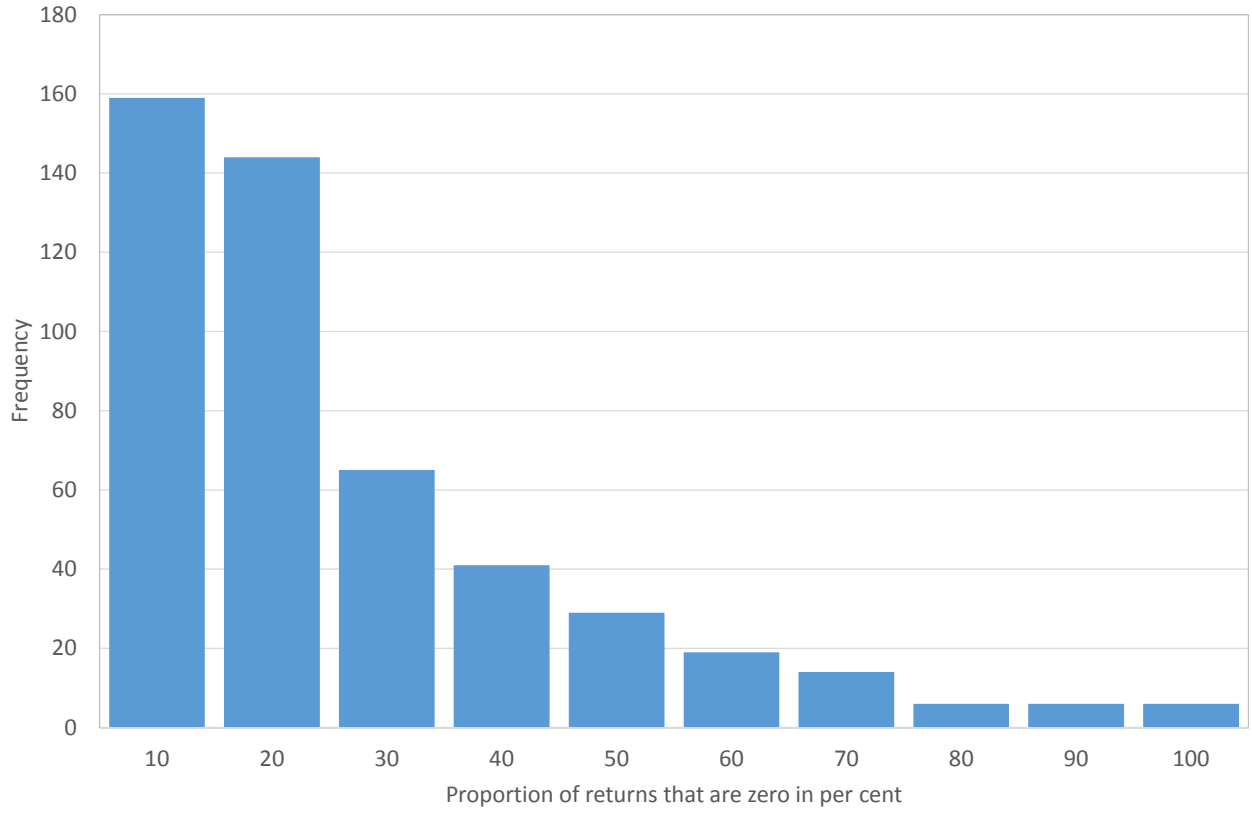
Campbell, J.Y., A.W. Lo and A.C. MacKinlay, *The econometrics of financial markets*, Princeton University Press, 1997, page 145.

Lo and MacKinlay label virtual returns.

Thus this analysis indicates that if the probability that a stock does not trade over a day is three quarters, then the beta of the stock computed using observed daily returns will be only one quarter of its true value. If the probability that a stock does not trade over a week is one half, then the beta of the stock computed using observed daily returns will be only one half of its true value.

Figure 1 below shows that for many stocks in the database provided to us by DBP – who, again, constructed the database by using the code supplied by the ERA – the proportion of daily returns over the last five years that are zero is high. For one stock, Payce Consolidated (PAY), only five of 1,265 daily returns over the last five years are not zero! To gauge what proportion of returns one might expect to be zero for stocks that trade frequently, Table 3 shows the proportion of daily returns that are zero for CBA, TLS and ANZ. For these stocks, the proportion of daily returns that are zero typically lies below 10 per cent.

Figure 1: Proportion of Returns in the ERA's Sample that are Zero Returns over the Last Five Years



Source: Volume data are from Bloomberg and were downloaded using code supplied by the ERA and provided to HoustonKemp by DBP.

Again, the ERA chooses as its sample of stocks current members of the All Ordinaries. Many of these stocks are stocks whose market capitalisations have grown and that now trade more frequently than they did in the past. This implies that the way in which the ERA computes returns on days when stocks do not trade coupled with its selection criterion produces an even larger problem when its sample consists of 20 years of data. This fact is illustrated by Figure 2, which shows that for an even larger number of stocks in the database the proportion of daily returns over the last 20 years that are zero is high.

A fifth problem is that, in computing an estimate of the zero-beta premium, the only restriction that the ERA places on the number of observations required to compute a past estimate of beta is that there be at least two observations. Since the ERA's selection criterion guarantees that more data are missing as one works

one's way back through time and because the regulator correctly records returns as missing before a price is recorded for a stock, it will be the case that some of the beta estimates on which the ERA relies will be constructed using very few observations. Estimates of beta that use few observations can be imprecise.

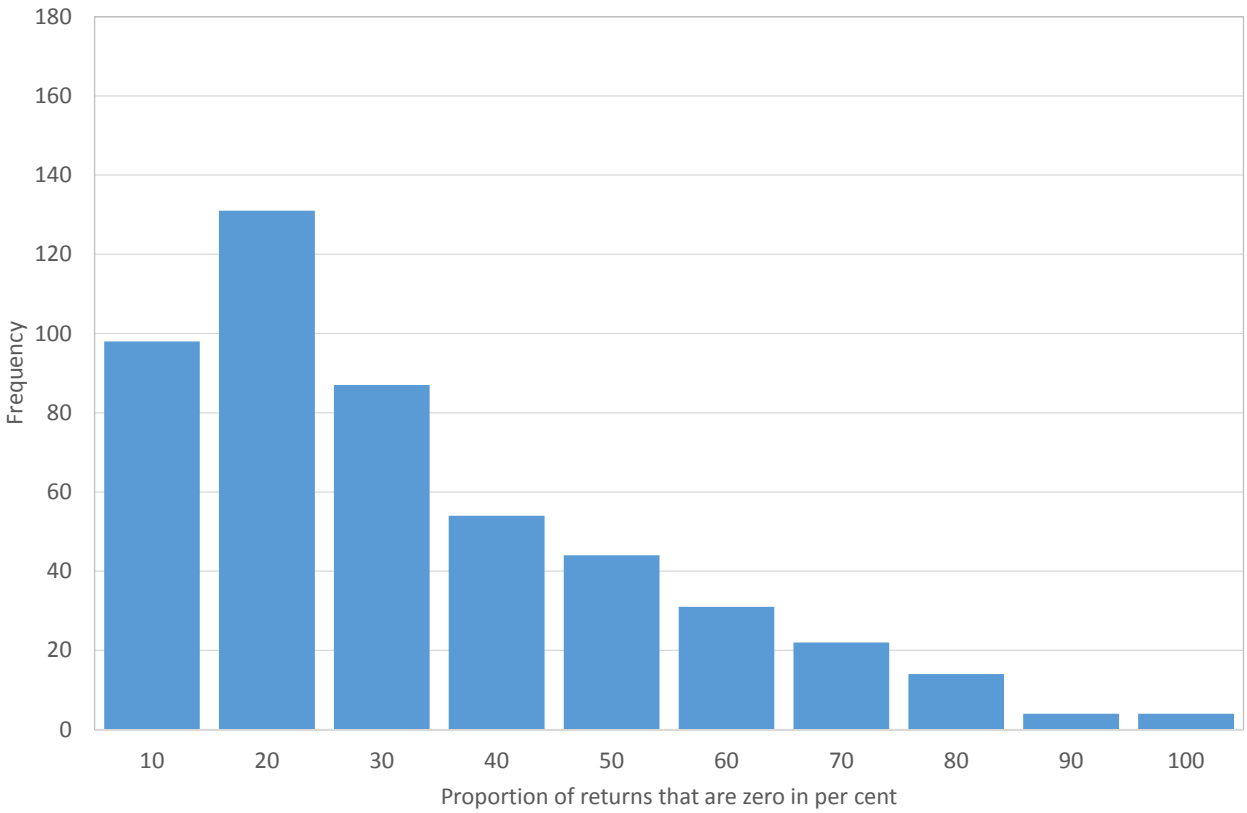
Table 3: Proportion of Daily Returns that are Zero for Frequently Traded Stocks

	Proportion of daily returns that are zero over the last	
Stock	5 years	20 years
CBA	1.50	1.84
TLS	10.12	7.55
ANZ	1.50	2.07

Note: Proportions of daily returns that are zero are in per cent.

Source: ERA returns computed using code supplied by the ERA and data from Bloomberg and provided to HoustonKemp by DBP.

Figure 2: Proportion of Returns in the ERA's Sample that are Zero Returns over the Last 20 Years



Source: Volume data are from Bloomberg and were downloaded using code supplied by the ERA and provided to HoustonKemp by DBP.

2.3 Other Evidence

The evidence that DBP provides in its December 2014 submission is consistent with evidence that others provide. [41]

CEG (2008) and SFG (2014) find no significant relation in Australian data between the returns to a cross-section of portfolios and estimates of the betas of the portfolios.[42] CEG uses data from January 1974 to December 2007 while SFG uses data from January 1994 to December 1994. CEG and SFG form portfolios, as DBP does, on the basis of past estimates of beta but in some of the tests that SFG conducts, it constructs portfolios in such a way as to eliminate any variation across the portfolios in book-to-market. With portfolios formed so as to eliminate the impact of any variation in book-to-market, SFG is able to find a positive relation between returns and estimates of beta but the relation that it finds is not statistically significant. With portfolios formed on past estimates of beta alone, SFG produces results that are similar to those that DBP reports and that CEG reports.

In US data, Lewellen, Nagel and Shanken (2010) find that there is little relation between mean return and beta and that estimates of the zero-beta premium are large and both economically and statistically significant.[43] Lewellen, Nagel and Shanken use two sets of portfolios to test a range of models. The first set of portfolios that Lewellen, Nagel and Shanken use are the 25 portfolios that Ken French provides on his web site that are formed on the basis of size (market capitalisation) and book-to-market.[44] The second set of portfolios are these 25 portfolios together with the 30 industry portfolios whose returns French also provides on his web site. Figure 3 plots the sample mean returns on these 55 portfolios in excess of the risk-free rate against estimates of their betas, indicated by the 55 blue markers, together with the relation that Lewellen, Nagel and Shanken estimate exists between mean excess return and beta for the portfolios, indicated by the red line. The figure indicates that there is little relation between the sample mean returns to the 55 portfolios and estimates of their betas and that estimates of the zero-beta premium are correspondingly large (the zero beta premium is recorded where the red line intersects the vertical axis). Lewellen, Nagel and Shanken report that a two-tailed test of the hypothesis that the zero-beta premium is zero can be rejected at the one per cent level or lower.[45] In other words, Lewellen, Nagel and Shanken find statistically significant evidence that the SL CAPM will deliver downwardly biased estimates of the returns required on low-beta portfolios of stocks.

[41] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12.*

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

SFG, *Cost of equity in the Black Capital Asset Pricing Model: Report for Jemena Gas Networks, ActewAGL, Networks NSW, Transend, Ergon and SA Power Networks*, May 2014.

[43] See their Table 1.

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

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

[45] The t-test statistic attached to the estimate of the zero-beta premium that Lewellen, Nagel and Shanken provide is 2.57. See their Table 1.

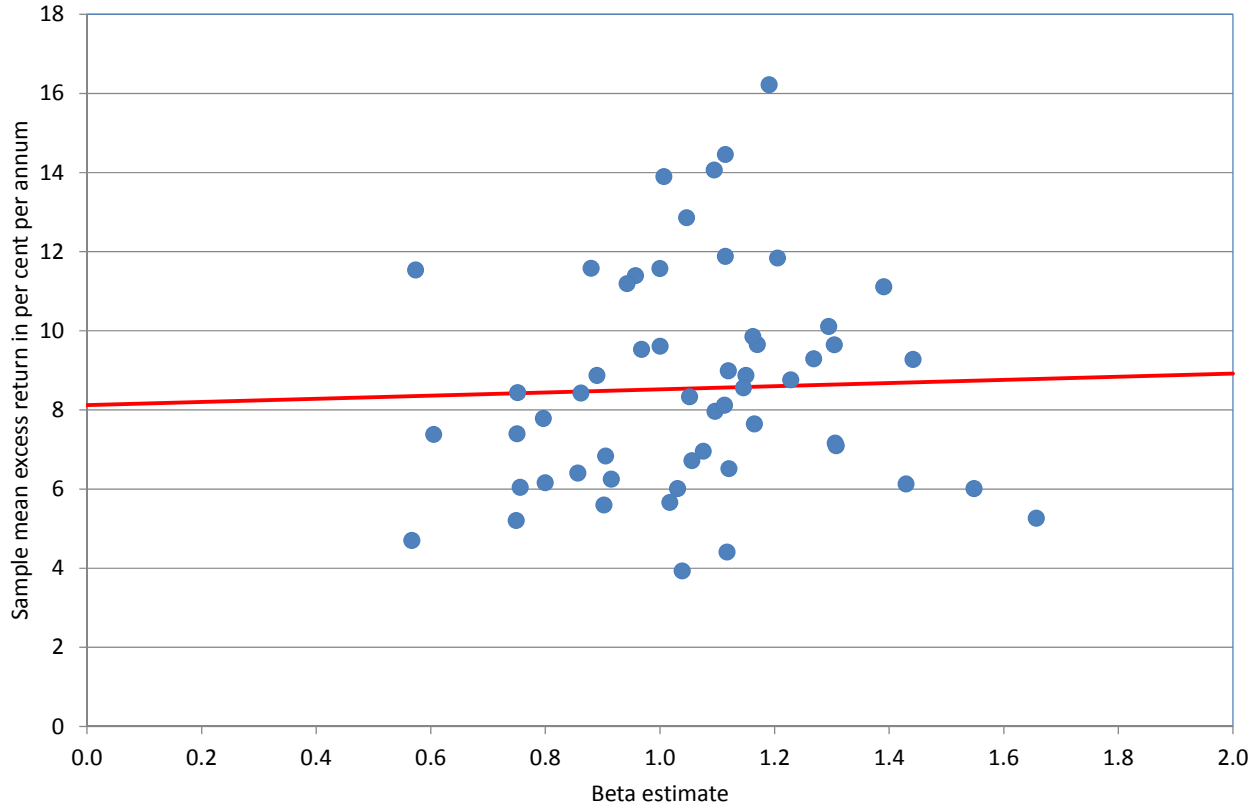
Lewellen, J., S. Nagel and J. Shanken, *A skeptical appraisal of asset pricing tests*, Journal of Financial Economics, 2010, Table 1, page 188.

In more recent work, Kan, Robotti and Shanken (2013) find in US data a significant negative relation on average between the returns to a cross section of portfolios and estimates of the betas of the portfolios using monthly data from February 1959 to July 2007.[46] They state that:

> 'As in many past studies, the market factor … is negatively priced in several specifications, contrary to the usual theoretical prediction.'

Included in the specifications to which they refer is the CAPM.

Figure 3: Sample Mean Excess Return against Beta Estimate for 25 US Size and Book-to-Market Sorted Portfolios and 30 US Industry Portfolios: Quarterly Data from 1963 to 2004



Notes: Data are from Ken French's web site and are those used by Lewellen, Nagel and Shanken (2010). The red line plots Lewellen, Nagel and Shanken's estimate of the relation between mean return and beta constructed from the 25 portfolios formed on the basis of size and book-to-market and the 30 industry portfolios.

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

Lewellen, J., S. Nagel and J. Shanken, A skeptical appraisal of asset pricing tests, Journal of Financial Economics, 2010, Table 1, pages 188.

[46] See their Table II.

Kan, R., C. Robotti and J. Shanken, *Pricing model performance and the two-pass cross-sectional regression methodology*, Journal of Finance, 2013, pages 2617-2649.

3. Issues Raised by the AER, ERA and their Advisers

In this section we respond to issues raised by the AER, ERA and their advisers about estimates of the zero-beta premium and the use of the Black CAPM.

3.1 Issues Raised by the ERA

The ERA refers to a number of arguments made by McKenzie and Partington in an August 2012 report. In particular, the ERA states that: [47]

> 'The Authority notes the view from Professors McKenzie and Partington (2012) in relation to the validity of the estimates of the zero beta premia. In relation to NERA's estimates of zero beta premium, Professors McKenzie and Partington were of the view that:
>
> > There are many potential sources of error and bias in the estimation of zero beta returns and consequently such estimates should be viewed with great caution. Even if the foregoing problems were set aside, there are also question marks over the standard errors of the zero beta return estimates. This is an important unresolved issue given that the magnitude of the standard error is the basis for concluding whether estimated zero beta returns differ from zero.
>
> In addition, in relation to the robustness of the estimated zero beta, McKenzie and Partington (2012) are of the view that robustness means that there is little or no variation of the estimated parameter in response to sensible alternative approaches to estimation. On this ground, McKenzie and Partington argue that NERA's estimates of the zero beta premiums are not robust. They also argued that:
>
> > We make a more general and more important point that "the empirical zero beta portfolio" is not unique. Consequently, there are many different zero beta returns that might be estimated and very large differences in the value of that return could be obtained.
>
> McKenzie and Partington were of the view that estimates of zero beta premiums are problematic. They considered that:
>
> > There is no generally accepted empirical measurement of the zero beta return in the Black CAPM. This is because the empirical measurement of the zero beta return is neither simple, nor transparent. There are many possible zero beta portfolios that might be used and the return on these portfolios is not directly observed, but has to be estimated. In the estimation process for the zero beta return, there are also inputs that cannot be observed and they too have to be estimated. The resulting estimate of the zero beta return is sensitive to the choices made in regard to the input variables and methods of estimation.'

The issues that McKenzie and Partington raise have already been comprehensively addressed by NERA in its June 2013 report and so we do not address them here. [48] NERA states that: [49]

> 'In recent advice to the AER, McKenzie and Partington (2012) make a number of arguments against the use of the Black CAPM. 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.

[47] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, pages 43-44.

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

NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, June 2013, pages 24-37.

[49] NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, June 2013, page 24.

> 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.'

3.2 Issues Raised by the AER

The AER, in its Jemena October 2015 draft decision, raises a large number of issues, most of which have been previously addressed by one or more of the consultants to the NSPs.[50] Here we limit our attention to three issues that the AER has raised that relate to the empirical work of NERA in its February 2015 report. [51]

First, we note that the AER states in its Jemena October 2015 draft decision about the February 2015 report of NERA that:[52]

> 'Several service providers resubmitted an empirical test of the SLCAPM and the Black CAPM by NERA that was considered in the JGN final decision. We continue to observe that the results in NERA's report appear counterintuitive. For instance, NERA's in-sample tests indicated there was a negative relation between returns and beta – which is not consistent with the theory underpinning the SLCAPM or the Black CAPM. NERA also provided an estimate of the zero-beta premium of 10.75 per cent. It has been acknowledged that it is implausible for the zero beta premium to be equal to or greater than the MRP.'

A similar passage appears in the AER's June 2015 *Jemena Gas Final Decision* and NERA shows in its June 2015 report that the AER has incorrectly attributed a view to NERA and SFG – that they view a large zero-beta premium to be implausible – that NERA and SFG do not hold.[53]

We also note that the ERA states in its DBP draft decision that: [54]

> 'DBP's model adequacy test produces nonsensical outcomes.'

The AER's claim that the results that NERA provides in its February 2015 report are counterintuitive, like the ERA's claim in its DBP draft decision that DBP's December 2014 results are nonsensical can be interpreted in three ways. One interpretation might be that the AER and ERA view the results as sufficiently unusual that they throw doubt on the reliability of DBP and NERA's empirical work. We make clear here, however, that the results are not unusual and that many others have produced very similar results. Again, the AER's adviser, Satchell, in work with Muijsson and Fishwick states that:[55]

> 'One of the observations over the cross section of stocks is that the historical risk-return trade-off is flat or inverted: within the CAPM one would expect that stocks with high systemic risk would outperform their low risk counterparts, but results have shown otherwise.'

Thus there is no evidence that DBP's December 2014 results and NERA's February 2015 results are unusual relative to the results produced by others.

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[50] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015.

[51] NERA, *The cost of equity: Response to the AER's final decisions: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pages 16-17.

[52] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 285.

[53] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, pages 251-252.

NERA, *The cost of equity: Response to the AER's final decisions: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pages 16-17.

[54] ERA, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 Appendix 4 Rate of return*, December 2015, page 42.

NERA, *Empirical performance of Sharpe-Lintner and Black CAPMs: A report for Jemena Gas Networks, Jemena Electricity Networks, ActewAGL, AusNet Services, CitiPower, Energex, Ergon Energy, Powercor, SA Power Networks, and United Energy*, February 2015.

[55] Muijsson, C., E. Fishwick and S. Satchell, Taking the art out of smart beta, University of Sydney, September 2014, page 2.

Another interpretation might be that the AER and ERA view the results produced by DBP, NERA and others as sufficiently unusual that they can be attributed to bad luck. The significance tests that DBP and NERA conduct and that others conduct, however, are designed to determine whether an outcome can be attributed to chance. The results that DBP and NERA provide and that others provide elsewhere indicate that it is difficult to attribute the evidence against the SL CAPM to bad luck. The Wald statistic for a test of the SL CAPM that employs DBP's Method B is, from Table 10 of DBP's submission, 29.79. [56] The p-value associated with this statistic is 0.00093. This means that were the SL CAPM to be true, one would expect to see a Wald statistic as large as 29.79 just 93 times out of every 100,000 independent tests conducted using similar data. Thus it is very unlikely that the results produced by DBP can be attributed to bad luck.

A final interpretation is that the AER and ERA believe that there is something wrong with the way in which DBP, NERA and others implement the model. In particular, the AER and ERA may believe that DBP, NERA and others use a poor proxy for the market portfolio. The proxy for the portfolio that DBP, NERA and others use, however, is the proxy that the AER and ERA use in implementing the model. It is a value-weighted index of stocks.

The evidence provided by DBP, NERA and others indicates that an empirical version of the SL CAPM that uses a value-weighted index of stocks as a proxy for the market portfolio does not work. This may be because the SL CAPM is true but the proxy is poor or it may be because the SL CAPM is false. Because we are never likely to measure properly the return to the market portfolio of all risky assets, we may never know. What we do know, however, is that an empirical version of the SL CAPM that uses a value-weighted index of stocks as a proxy for the market portfolio – that is, the version that the AER and ERA employ – does not work. In particular, an empirical version of the SL CAPM that uses a value-weighted index of stocks as a proxy for the market portfolio provides estimates of the returns required on low-beta assets that are biased downwards.

Second, we note that the AER states in its Jemena June 2015 final decision about Partington's views that:[57]

> 'Partington previously noted that the foundation model does not provide a downwardly biased estimate in the current context. He also advised:
>
> > The theoretical justification for a downward bias has previously been considered in McKenzie and Partington (2012, p. 19-20) and they do not find in favour of this argument in this context. We also do not view the statistical justification (see SFG (2013a, p. 5), SFG (2014a, p. 10-12) for a discussion of the Vasicek adjustment) as valid in this context.'

As NERA points out in its June 2015 report, Partington responds to a question about whether the AER's 'foundation model' will deliver unbiased estimates of the return required on the equity of an NSP by discussing whether there is evidence that the beta of a regulated utility tends to revert to one over time.[58] Partington concludes that there is little evidence in the data for mean reversion in betas and so concludes that the use of the SL CAPM will not generate downwardly biased estimates of the cost of equity capital for a benchmark efficient entity. An absence of mean reversion in betas, however, will not guarantee that the use of the SL CAPM will generate estimates of the cost of equity capital for a benchmark efficient entity that are not downwardly biased.

Third, the AER states in its Jemena June 2015 final decision that:[59]

> 'McKenzie and Partington … stated:

[56] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12*, page 66.

[57] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 287.

[58] NERA, *The cost of equity: Response to the AER's final decisions: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pages 32-33.

[59] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 65.

> …recent work suggests that the evidence against the CAPM may not be as robust as previously thought. For example, Ray, Savin and Tiwari (2009) show that the statistical evidence for rejecting the CAPM is weaker than previously thought when more appropriate statistical tests are used. More importantly, Da, Guo and Jagannathan (2012) argue that the empirical evidence against the capital asset pricing model (CAPM) based on stock returns does not invalidate its use for estimating the cost of capital for projects in making capital budgeting decisions. Their argument is that stocks are backed not only by projects in place, but also by the options to modify current projects and even undertake new ones. Consequently, the expected returns on equity need not satisfy the CAPM even when expected returns of projects do. Thus, their findings justify the continued use of the CAPM irrespective as to one's interpretation of the empirical literature on asset pricing.'

and later, presumably in reference to the passage above from McKenzie and Partington's October 2014 report, that:[60]

- The evidence against the SLCAPM may not be as robust as once thought when more appropriate statistical tests are used.
- The empirical evidence against the model does not invalidate its use for estimating the cost of capital for projects when making capital budgeting decisions.

The ERA also makes similar references to the work of Ray, Savin and Tiwari (2009) and Da, Guo and Jagannathan (2012). [61]

NERA in a June 2015 report states about the work of Ray, Savin and Tiwari (2009) that:[62]

> 'The AER in its *Guidelines* and McKenzie and Partington in their October 2014 report refer to the work of Ray, Savin and Tiwari (2009) who show that the finite-sample distribution of the Wald statistic for a test of the SL CAPM need not conform closely to its theoretical asymptotic distribution. As we explain in section 2, for this reason, NERA in its February 2015 report conducts bootstrap simulations to ensure that inference is correctly drawn. The simulation results reveal that the SL CAPM can be rejected at conventional levels of significance regardless of whether inference is based on the finite-sample or theoretical asymptotic distribution of the Wald statistic. Thus NERA responds to the concerns that the AER and McKenzie and Partington raise.'

DBP in its December 2014 submission similarly conducts bootstrap simulations to ensure that inference is correctly drawn. [63] The simulation results reveal that the SL CAPM can be rejected at conventional levels of significance regardless of whether inference is based on the finite-sample or theoretical asymptotic distribution of the Wald statistic. Thus DBP also responds to the concerns that the AER and McKenzie and Partington raise and that now the ERA resurrect.

NERA in a June 2015 report states about the work of Da, Guo and Jagannathan (2012) that:[64]

[60] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 286.

[61] Da, Z., R-J. Guo and R. Jagannathan, *CAPM for estimating the cost of equity capital: Interpreting the empirical evidence*, Journal of Financial Economics, 2012, pages 204-220.

Ray, S., N.E. Savin and A. Tiwari, *Testing the CAPM revisited*, Journal of Empirical Finance, 2009, pages 721-733.

[62] NERA, *The cost of equity: Response to the AER's final decisions: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pages 22-23.

Ray, S., N.E. Savin and A. Tiwari, *Testing the CAPM revisited*, Journal of Empirical Finance, 2009, pages 721-733.

[63] DBP, *Proposed Revisions DBNGP Access Arrangement 2016-2020 Regulatory Period.Rate of Return Supporting Submission: 12 App D*.

[64] Da, Z., R-J. Guo and R. Jagannathan, *CAPM for estimating the cost of equity capital: Interpreting the empirical evidence*, Journal of Financial Economics, 2012, pages 204-220.

NERA, *The cost of equity: Response to the AER's final decisions: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pages 23-25.

> 'In recent work, Da, Guo and Jagannathan (2012) argue that growth options that firms possess may be largely responsible for the weak relation between return and beta. McKenzie and Partington state in their October 2014 report that:
>
> > 'Da, Guo and Jagannathan (2012) argue that the empirical evidence against the capital asset pricing model (CAPM) based on stock returns does not invalidate its use for estimating the cost of capital for projects in making capital budgeting decisions. Their argument is that stocks are backed not only by projects in place, but also by the options to modify current projects and even undertake new ones. Consequently, the expected returns on equity need not satisfy the CAPM even when expected returns of projects do. Thus, their findings justify the continued use of the CAPM irrespective as to one's interpretation of the empirical literature on asset pricing.'
>
> NERA in its February 2015 report states that:
>
> > 'What McKenzie and Partington do not explain is that Da, Guo and Jagannathan do not suggest that the SL CAPM be used in the same way that the AER has been using the model. To construct estimates of beta that can be used in project evaluation, unadjusted common or garden estimates of beta have to be adjusted. Da, Guo and Jagannathan (2012) state that:
> >
> > > 'In general, both the equity risk premium and the equity beta of a firm are complex functions of the firm's project beta and real option characteristics. If we project them on a set of variables capturing the features of real options using linear regressions, the residual risk premium and the residual beta are option-adjusted and more closely resemble the underlying project risk premium and project beta.'
> >
> > Since beta is a relative measure of risk, an adjustment must be made even to the betas of firms that have no growth options. Da, Guo and Jagannathan construct option-adjusted betas as the residuals from a cross-sectional regression, without an intercept, of unadjusted betas on book-to-market, idiosyncratic volatility and the return on assets where the three regressors are measured relative to averages for the market. Neither the AER nor its advisers construct estimates of beta in this way. Thus the evidence that Da, Guo and Jagannathan provide is not relevant to assessing estimates of the cost of equity provided by the empirical version of the SL CAPM that the AER employs.''

3.3 Issues Raised by the AER's Advisers

Partington and Satchell in their October 2015 report state about estimates of the zero-beta premium that:[65]

> 'estimates, such as those of the zero beta return, are so problematic and unreliable as to render them virtually worthless.'

In a January 2016 update of the empirical evidence on a number of pricing models – the Black CAPM among them – we use 622 monthly estimates of the zero-beta premium from March 1963 to November 2014. [66] The analysis of Fama (1976) implies that a Fama-MacBeth (1973) estimate of the zero-beta premium is the realised excess return to a portfolio of hedged positions in the risky assets that the estimate employs. [67] It can be similarly shown that the Litzenberger-Ramaswamy (1979) estimate of the zero-beta premium is the realised excess return to a portfolio of hedged positions, adjusted for the error with which one estimates beta, in the risky assets.[68] The point that Partington and Satchell make is that there is a chance – albeit very, very small – that one of these realised excess returns will be extremely large and negative or extremely large and positive.

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[65] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 18.

[66] HoustonKemp, *The cost of equity: Response to the AER's draft decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks*, January 2016.

[67] Fama, Eugene F., *Foundations of finance*, Basic Books, 1976, Chapter 9.

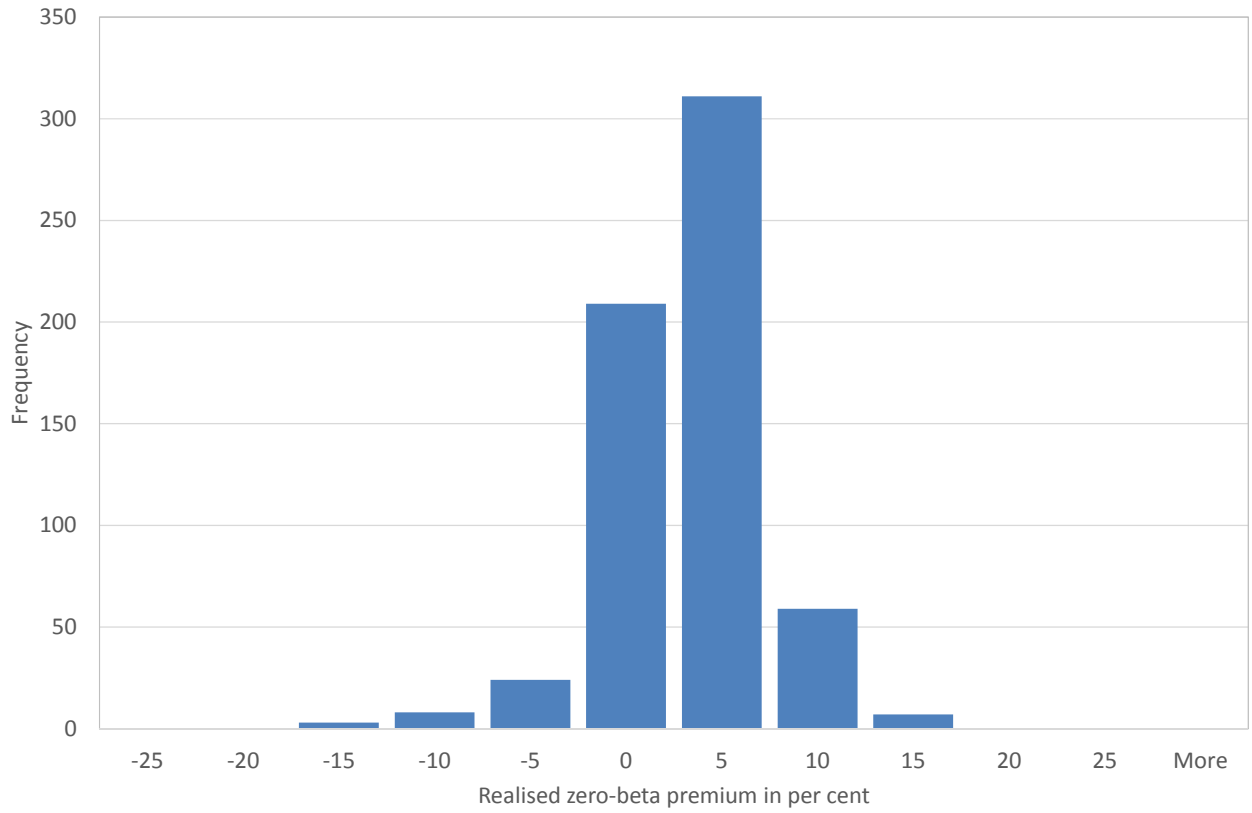
Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

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

To examine whether any of the 622 monthly estimates that we compute fall into this category, we provide in Figure 4 a histogram that summarises the behaviour of the data. The figure shows that none of the estimates is either extremely large and negative or extremely large and positive. The distribution of the estimates resembles the distribution of the return to a portfolio of stocks – as one would expect to be the case.

Figure 5 shows that the recursive estimates of the zero-beta premium that we compute have been relatively stable for the last 30 years and do not appear to be either problematic or unreliable. Estimates of the zero-beta premium are of a similar magnitude as estimates of the *MRP* and so the predictions that the Black CAPM makes are similar to those that a naïve model makes. The evidence that we provide in our January 2016 update suggests that the Black CAPM provides estimates of the return required on equity that are unbiased whereas the SL CAPM provides estimates that are biased.[69] This suggests that the argument that Partington and Satchell make that estimates of the zero-beta rate are 'virtually worthless' is incorrect.

Figure 4: Estimates of the Zero-Beta Premium



Note: The monthly estimates use the largest 100 stocks from 1963 to 1973, the largest 500 stocks from 1974 to 2013 and the two-pass methodology of Fama and MacBeth (1973) as modified by Litzenberger and Ramaswamy (1979).

Partington and Satchell also claim in their October 2015 report that:[70]

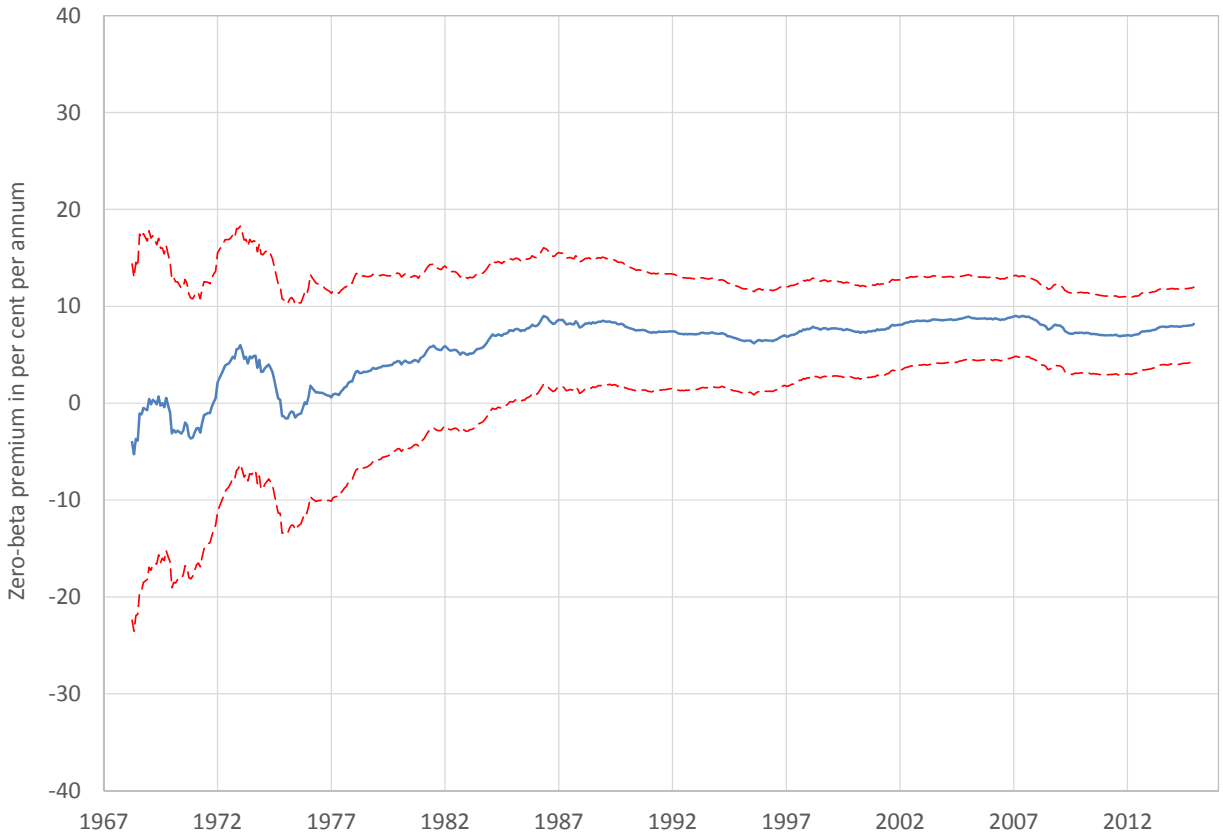
> 'another problem with the zero beta estimate relative to the government bond rate [is that] it is not current. The current government bond rate is readily observed, the zero beta return has to be estimated. In the case above it takes twenty years of data to do so.'

[69] HoustonKemp, *The cost of equity: Response to the AER's draft decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks*, January 2016.

[70] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 20.

This argument ignores the fact that DBP, NERA, SFG and we use an estimate of the zero-beta rate formed by adding an estimate of the zero-beta premium to the current risk-free rate in exactly the same way that Partington and Satchell argue that one should form an estimate of the mean return to the market – by adding an historical estimate of the *MRP* to the current risk-free rate. While there may be variation in the zero-beta premium, as we believe there is in the *MRP*, the evidence that DBP provides indicates that a model that ignores any variation is nevertheless able to generate forecasts of returns that exhibit no significant bias whereas forecasts generated by the ERA's implementation of the SL CAPM exhibit a significant bias.

Figure 5: Recursive Estimates of the Zero-Beta Premium with 95 Per Cent Confidence Intervals



Note: The estimates use the largest 100 stocks from 1963 to 1973, the largest 500 stocks from 1974 to 2014 and the two-pass methodology of Fama and MacBeth (1973) as modified by Litzenberger and Ramaswamy (1979). For each month t we compute a recursive estimate for the month as the average of all monthly zero-beta premium estimates up until month t −1. The estimates are annualised by multiplying them by 1200 and we plot all estimates that use at least five years of data. The estimates themselves plot along the blue solid line while the dashed red lines show 95 per cent confidence intervals for the estimates.

McKenzie and Partington refer to the work of Beaulieu, Dufour and Khalaf (2012) in an August 2012 report and, in a June 2013 report for the Energy Networks Association, NERA addresses the issues that McKenzie and Partington raise.[71] Partington and Satchell raise further issues. Partington and Satchell state in their October 2015 report that:

> 'we note that the paper by Beaulieu, Dufour and Khalaf (2012), reinforces our most recent discussion of technical problems in the estimation of zero beta returns.'

> 'Using γ as the notation for the return on the zero beta portfolio Beaulieu, Dufour and Khalaf observe (p3):

[71] Beaulieu, M-C., J-M Dufour and L. Khalaf, *Identification-robust estimation and testing of the zero-beta CAPM*, Review of Economic Studies, 2012, pages 1-33.

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

NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, June 2013, pages 35-36.

> Identification: as $\beta i \to 1$, γ becomes weakly identified. Weak identification (WI) strongly affects the distributions of estimators and test statistics, leading to unreliable inference even asymptotically. This should not be taken lightly: reported betas are often close to one (see e.g. Fama and MacBeth, 1973). Further, even if estimated betas are not close to one, irregularities associated with WI are not at all precluded [in view of (1) and (2) above].

> Beaulieu, Dufour and Khalaf have been working on this problem for over a decade and have developed improved estimation procedures. Applying these procedures they conclude that the estimate of the zero beta return is unstable over time.'

The point that Beaulieu, Dufour and Khalaf make is that if the set of assets that one uses to estimate the zero-beta rate all have true betas that are close to one, then it will be difficult to produce reliable estimates of the rate. The estimates that we produce of the zero-beta premium in our January 2016 report use the largest 100 stocks from 1963 to 1973 and the largest 500 stocks from 1974 to 2014 and it is unlikely that all of these stocks have true betas that are close to one.[72]

In addition, as NERA notes in its June 2013 report:[73]

> '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. We … 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 … should be revised in any significant way.'
>
> '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.'

Finally, we note that Beaulieu, Dufour and Khalaf find that estimates of the zero-beta rate are unstable through time but do not examine the stability of estimates of the zero-beta premium. Again, DBP, NERA and SFG and we compute an estimate of the zero-beta rate by adding an estimate of the zero-beta premium to the current risk-free rate and so the evidence that Beaulieu, Dufour and Khalaf provide about the instability of estimates of the zero-beta rate is of little relevance to our work and the work of DBP, NERA and SFG.

Partington and Satchell state in their October 2015 report about the work of Kan, Robotti and Shanken (2013) that:[74]

> 'NERA (2015, Re) makes reference to Kan, Robotti and Shanken (2013) in support of the superiority of the three factor model over the CAPM. The results, however, depend upon the characteristics used in sorting stocks into portfolios. When portfolios are formed by ranking on size and CAPM beta, rather than size and book to market, the superiority of the Fama and French three factor model disappears.'

[72] It is likely that many stocks will have betas that are less than one and many stocks will have betas that exceed one because of differences among firms in operating leverage and the type of product or service that the firms deliver.

[73] NERA, *Estimates of the zero-beta premium: A report for the Energy Networks Association*, June 2013, page 36.

[74] Kan, R., C. Robotti and J. Shanken, *Pricing model performance and the two-pass cross-sectional regression methodology*, Journal of Finance, 2013, pages 2617-2649.

Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 23-24.

What Partington and Satchell mean here is that when portfolios are formed in this way the Fama-French three-factor model cannot be shown to be superior to the CAPM. Kan, Robotti and Shanken do not say that when portfolios are formed in this way that the CAPM can be shown to be superior to the Fama-French three-factor model. In the abstract to their paper, Kan, Robotti and Shanken state that:

> 'Over the years, many asset pricing studies have employed the sample cross-sectional regression (CSR) R^2 as a measure of model performance. We derive the asymptotic distribution of this statistic and develop associated model comparison tests, taking into account the inevitable impact of model misspecification on the variability of the two-pass CSR estimates. We encounter several examples of large R^2 differences that are not statistically significant. A version of the intertemporal CAPM exhibits the best overall performance, followed by the "three-factor model" of Fama and French (1993).'

We note that the intertemporal CAPM is not the SL CAPM and that Kan, Robotti and Shanken are, of course, the authors of the paper and so in a good position to be able to summarise the results of their work succinctly – which is what they have done in the abstract to the paper. Kan, Robotti and Shanken find evidence that the Fama-French three-factor model significantly outperforms the CAPM and no evidence that the CAPM can outperform the three-factor model when performance is judged on the basis of generalised least squares (GLS) R^2.

A close inspection of the results that Kan, Robotti and Shanken (2013) provide shows that the GLS R^2 associated with the CAPM exceeds zero not because of a positive relation between the mean returns to the 29 portfolios that they use and their betas computed relative to a value-weighted portfolio of stocks but because of a significant negative relation between the mean returns and betas.[75] The evidence that Kan, Robotti and Shanken provide using US data is, therefore, again, similar to the evidence that we provide here using Australian data. The evidence is also consistent with an assessment of the existing evidence on the relation across stocks between returns and estimates of beta that Satchell provides elsewhere. To repeat, Satchell in work with Muijsson and Fishwick states that:[76]

> 'One of the observations over the cross section of stocks is that the historical risk-return trade-off is flat or inverted: within the CAPM one would expect that stocks with high systemic risk would outperform their low risk counterparts, but results have shown otherwise.'

Finally, Partington and Satchell also state that Kan, Robotti and Shanken:[77]

> 'find the zero beta estimates to be implausibly high (p.2620):
>
> > …most of the estimated zero-beta rates are far too high to be consistent with plausible spreads between borrowing and lending rates, as required by theory.'

Estimates that are 'implausibly high' and estimates that are 'too high to be consistent with plausible spreads between borrowing and lending rates, as required by theory' are two different things. Estimates that are implausibly high are estimates that may be viewed as unreliable and so estimates on which one might not place too much weight. Estimates that are too high to be consistent with a theory, on the other hand, are estimates that suggest either that the theory is wrong or that the data used to test the theory is not the data that the theory requires one use. There is no sign in their work that Kan, Robotti and Shanken (2013) view the estimates that they produce as being implausibly high in the sense of being unreliable.[78]

[75] See their Table II.

Kan, R., C. Robotti and J. Shanken, *Pricing model performance and the two-pass cross-sectional regression methodology*, Journal of Finance, 2013, pages 2617-2649.

[76] Muijsson, C., E. Fishwick and S. Satchell, *Taking the art out of smart beta*, University of Sydney, September 2014, page 2.

[77] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 24.

[78] Kan, R., C. Robotti and J. Shanken, *Pricing model performance and the two-pass cross-sectional regression methodology*, Journal of Finance, 2013, pages 2617-2649.

A1. Methodology

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

The Black CAPM imposes the following restriction:

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

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, that is, the zero-beta premium. If $\gamma_{0t} = 0$, then (A.1) collapses to the SL CAPM. If, on the other hand, $\gamma_{0t} > 0$, then the SL CAPM will not hold.

In its draft decision, the ERA uses the two-pass procedure of Fama and MacBeth (1973) to estimate the zero-beta premium.[79] One of the problems that can be associated with the two-pass procedure is that since a least squares estimate of the beta of a security measures the parameter with error, the second-pass estimator of γ_{0t} will be biased. Litzenberger and Ramaswamy (1979) modify the second-pass estimator to take into account this errors-in-variables problem.[80] In its draft decision, the ERA uses the two-pass procedure of Fama and MacBeth as modified by Litzenberger and Ramaswamy and Shanken (1992) to estimate the zero-beta premium.[81]

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 (1979), the ERA chooses the number of months S used to compute the estimates to be 60.[82]

In the second pass, for each month t, 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 $\hat{y}_{jt} = z_{jt} - \hat{\beta}_{jt} z_{mt}$, $\hat{x}_{jt} = 1 - \hat{\beta}_{jt}$ and $\hat{\beta}_{jt}$ is the least squares estimate of β_{jt} computed using data from $t-S$ to $t-1$. The modified estimator that Shanken (1992) suggests that one use and that the ERA uses is:[83]

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

[80] 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.

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

[82] 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.

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

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

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 $t-1$, $\hat{\sigma}_{mt}^2$ 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 $t-1$ and $\lambda = (S-2)/((S-1)(S-4))$. [84]

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

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

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

For further details, see Shanken (1992).

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

A2. Aggregation

This appendix examines the relation between Fama-MacBeth estimates of the zero-beta premium that use daily, weekly and monthly data when returns are continuously compounded, betas are known and are constant through time and the number of stocks that the estimates use is constant through time.

If betas are known and are constant through time and the number of stocks is constant through time, then an estimate of the zero-beta premium can be produced, for each day *s* of week or month *t*, from the regression:

$$y_{jst} = x_j \gamma_{0st} + \eta_{jst}, \qquad j = 1,2,...,N, \quad s = 1,2,...,M, \quad t = 1,2,...,T, \tag{A.5}$$

where $y_{jst} = z_{jst} - \beta_j z_{mst}$, $x_j = 1 - \beta_j$, returns are continuously compounded and we assume, for simplicity, that there are M days in a week or month.

Since the betas are known, there is no need to use Litzenberger and Ramaswamy's modification of Fama and MacBeth's method to estimate the zero-beta premium. Instead, an estimate of the zero-beta premium computed using daily data will be given by:

$$\hat{\gamma}_{0st} = \left(\sum_{j=1}^{N} x_j^2 \right)^{-1} \sum_{j=1}^{N} x_j y_{jst}, \tag{A.6}$$

while an estimate of the zero-beta premium computed using weekly or monthly data will be given by:

$$\hat{\gamma}_{0t} = \left(\sum_{j=1}^{N} x_j^2 \right)^{-1} \sum_{j=1}^{N} x_j \sum_{s=1}^{M} y_{jst}, \tag{A.7}$$

But

$$\hat{\gamma}_{0t} = \left(\sum_{j=1}^{N} x_j^2 \right)^{-1} \sum_{j=1}^{N} x_j \sum_{s=1}^{M} y_{jst} = \sum_{s=1}^{M} \left(\sum_{j=1}^{N} x_j^2 \right)^{-1} \sum_{j=1}^{N} x_j y_{jst} = \sum_{s=1}^{M} \hat{\gamma}_{0st} \tag{A.8}$$

Thus, under these conditions, it will make no difference whether one sums up daily Fama-MacBeth estimates to produce weekly or monthly estimates of the zero-beta premium or one sums up daily returns to produce weekly and monthly returns and then used these returns to produce weekly and monthly estimates.

A3. Terms of Reference

Expert Terms of Reference

DBP Zero-Beta Premium Consultant Brief

2016-20 DBNGP Access Arrangement 5 January 2016

In its *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 - 2020*, dated 22 December 2015 (**Draft Decision**), the ERA rejected the "model adequacy test", relied on by DBP in estimating the return on equity as part of its Access Arrangement Proposal dated 31 December 2014, on conceptual and empirical grounds. One of the empirical grounds is that the estimates of the zero-beta premium from NERA (see p213 of Appendix 4 to the Draft Decision and Appendix 4A (i), commencing page 175) are problematical.

In respect of the previous NERA zero-beta premium work, the ERA repeats many arguments made by itself and the AER in respect of Black CAPM and the zero-beta premium generally (p43-4 of Appendix 4), and then notes on p44 of Appendix 4 that it has confirmed the inefficiency of the zero-beta portfolio, to the extent that it does not lie on the mean variance efficient frontier.

While the ERA has not presented this evidence (it is not contained within Appendix 4A (i) to the Draft Decision), it has provided econometric code on December 24th 2015 (at DBP's request) which does appear to calculate a mean-variance efficient frontier and the place of its own zero-beta portfolio on this frontier.

1. DBP requires the expert to examine the code (and any evidence subsequently provided by the ERA – as a separate piece of work not part of the fixed fee), which we will provide, and run the relevant regressions to assess and then to provide an expert opinion as to whether you agree with the ERA's conclusion concerning the inefficiency of the zero-beta portfolio.[1]

Further, in Appendix 4A(i) (commencing page 175), the ERA undertakes a discussion on the different approaches to estimating the Black CAPM, and then presents the results of its own estimation of this model.

2. DBP requires an expert opinion concerning the various issues raised in the ERA's discussion in relation to the empirical performance of the Black CAPM, including:
    a. where relevant, cross references to other submissions made by other service providers to the ERA and AER, where the points made by the ERA have been addressed elsewhere and are not novel; and
    b. an assessment of the ERA's own Black CAPM calculations to assess whether they represent "best practice" and having regard to the allowed rate of return objective in Rule 87 of the National Gas Rules.

Please provide a short written, fixed fee, quotation responding to the points above by the 8th of January. Given the tight timeframes required for a response to the regulator, it is anticipated that all work will be completed to a Draft Report stage by February 5th, with comments back from DBP by February 12th and a Final Report by February 19th. Also having regard to those timeframes, this request for quotation, including the particular questions raised above, is provided to you as a draft in the first instance. We anticipate working closely with consultants during the project to address any additional issues as they arise. If, having regard to additional issues that arise, it becomes necessary to seek your opinion on additional or different matters, we

[1] This will require access to a Bloomberg terminal. If the consultant is based in Melbourne, and able to run the regression before January 29th, DBP is able to assist in this regard.

will seek to agree that additional or revised scope with you. Accordingly, please also provide an hourly rate for relevant consultants to allow for an expansion of scope where this becomes necessary.

Since it is possible that your expert report may be relied on in future proceedings before the Australian Competition Tribunal, we require that the work be undertaken in accordance with the Federal Court Guidelines for Expert Witnesses (attached). Further, your report should contain a declaration that you have been given and have read, understood and complied with Practice Note CM7 issued by the Federal Court of Australia concerning guidelines for expert witnesses. It should also contain a declaration that you have made all the inquiries that you believe are desirable and appropriate and that no matters of significance that you regard as relevant have, to your knowledge, been withheld.

A4. Federal Court Guidelines

FEDERAL COURT OF AUSTRALIA
Practice Note CM 7

EXPERT WITNESSES IN PROCEEDINGS IN THE FEDERAL COURT OF AUSTRALIA

Practice Note CM 7 issued on 1 August 2011 is revoked with effect from midnight on 3 June 2013 and the following Practice Note is substituted.

Commencement

1. This Practice Note commences on 4 June 2013.

Introduction

2. 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)).

3. 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[85], 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[86]

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[87]

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

[85] 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].

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

[87] Rule 23.13.

(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

(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

(ga) contain an acknowledgment that the expert's opinions are based wholly or substantially on the specialised knowledge mentioned in paragraph (c) above[88]; and

(h) comply with the Practice Note.

2.2 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*."

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

2.4 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[89].

2.5 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.

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

2.7 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[90].

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.

J L B ALLSOP
Chief Justice
4 June 2013

[88] See also *Dasreef Pty Limited v Nawaf Hawchar* [2011] HCA 21.

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

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

A5. Curriculum Vitae

Simon M. Wheatley

Tel: +61 3 9878 7985
E-mail: swhe4155@bigpond.net.au

Overview

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

Employment

- Special Adviser, HoustonKemp, 2015-
- Affiliated Industry Expert, NERA Economic Consulting, 2014-2015
- Special Consultant, NERA Economic Consulting, 2009-2014
- 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

HoustonKemp

- The Cost of Equity: Response to the AER's Draft Decisions for the Victorian Electricity Distributors, ActewAGL Distribution and Australian Gas Networks: A Report for ActewAGL Distribution, AusNet Services, Australian Gas Networks, CitiPower, Jemena Electricity Networks, Powercor and United Energy, January 2016
- Equity Beta for a Benchmark Australian Water Network Service Provider: A report for Sydney Water, June 2015 (with Greg Houston, Brendan Quach and Dale Yeats)

NERA

- Estimating Distribution and Redemption Rates: Response to the AER's Final Decisions for the NSW and ACT Electricity Distributors, and for Jemena Gas Networks: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy, June 2015
- Further Assessment of the Historical MRP: Response to the AER's Final Decisions for the NSW and ACT Electricity Distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy, June 2015
- The Cost of Equity: Response to the AER's Final Decisions for the NSW and ACT Electricity Distributors, and for Jemena Gas Networks: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy, June 2015
- The Cost of Equity: A Critical Review of the Analysis of the AER and its Advisors: A report for DBP, June 2015
- Do Imputation Credits Lower the Cost of Equity? Cross-Sectional Tests: A report for United Energy, April 2015
- The Relation Between the Market Risk Premium and Risk-Free Rate: Evidence from Independent Expert Reports: A report for United Energy, April 2015
- Review of the Literature in Support of the Sharpe-Lintner CAPM, the Black CAPM and the Fama-French Three-Factor Model A report for Jemena Gas Networks, Jemena Electricity Networks, AusNet Services, Australian Gas Networks, CitiPower, Ergon Energy, Powercor, SA PowerNetworks, and United Energy, March 2015
- Estimating Distribution and Redemption Rates from Taxation Statistics A report for Jemena Gas Networks, Jemena Electricity Networks, AusNet Services, Australian Gas Networks, CitiPower, Ergon Energy, Powercor, SA PowerNetworks and United Energy, March 2015
- Empirical performance of Sharpe-Lintner and Black CAPMs: A report for Jemena Gas Networks, Jemena Electricity Networks, ActewAGL, AusNet Services, CitiPower, Energex, Ergon Energy, Powercor, SA Power Networks, and United Energy, February 2015
- Historical estimates of the market risk premium: A report for Jemena Gas Networks, Jemena Electricity Networks, ActewAGL, Ausgrid, AusNet Services, Australian Gas Networks, CitiPower, Endeavour Energy, Energex, Ergon, Essential Energy, Powercor, SA Power Networks and United Energy, February 2015
- Robust regression techniques: A report for DBP, December 2014

- Imputation Credits and Equity Returns: A report for the Energy Networks Association, October 2013 (with Brendan Quach)
- The Fama-French Three-Factor Model: A report for the Energy Networks Association, October 2013 (with Brendan Quach)
- The Market Risk Premium: Analysis in Response to the AER's Draft Rate of Return Guidelines: A report for the Energy Networks Association, October 2013 (with Brendan Quach)
- The Market, Size and Value Premiums: A report for the Energy Networks Association, June 2013 (with Brendan Quach)
- Estimates of the Zero-Beta Premium: A report for the Energy Networks Association, June 2013 (with Brendan Quach)
- The Payout Ratio: A report for the Energy Networks Association, June 2013 (with Brendan Quach)
- Review of Cost of Equity Models: A report for the Energy Networks Association, June 2013 (with Brendan Quach)
- 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 (with Brendan Quach)
- The Cost of Equity for a Regulated Energy Utility: A report for Multinet, February 2013 (with Brendan Quach)
- The Black CAPM: A report for APA Group, Envestra, Multinet & SP AusNet, March 2012 (with Brendan Quach)
- Prevailing Conditions and the Market Risk Premium: A report for APA Group, Envestra, Multinet & SP AusNet, March 2012 (with Brendan Quach)
- The Market Risk Premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy, 20 February 2012 (with Brendan Quach)
- Cost of Equity in the ERA DBNGP Draft Decision: A report for DBNGP, 17 May 2011 (with Brendan Quach)
- The Market Risk Premium: A report for Multinet Gas and SP AusNet, 29 April 2011 (with Brendan Quach)
- Cost of Capital for Water Infrastructure Company Report for the Queensland Competition Authority, 28 March 2011 (with Brendan Quach)
- The Cost of Equity: A report for Orion, 2 September 2010 (with Greg Houston and Brendan Quach)
- New Gamma Issues Raised by AER Expert Consultants: A report for JGN, 17 May 2010 (with Brendan Quach)
- The Required Rate of Return on Equity for a Gas Transmission Pipeline: A Report for DBP, 31 March 2010 (with Brendan Quach)
- Jemena Access Arrangement Proposal for the NSW Gas Networks: AER Draft Decision: A report for Jemena, 19 March 2010 (with Greg Houston and Brendan Quach)
- Payout Ratio of Regulated Firms: A report for Gilbert + Tobin, 5 January 2010 (with Brendan Quach)

- Review of Da, Guo and Jagannathan Empirical Evidence on the CAPM: A report for Jemena Gas Networks, 21 December 2009 (with Greg Houston and Brendan Quach)
- The Value of Imputation Credits for a Regulated Gas Distribution Business: A report for WA Gas Networks, 18 August 2009 (with Greg Houston, Brendan Quach and Tara D'Souza)
- Cost of Equity - Fama-French Three-Factor Model Jemena Gas Networks (NSW), 12 August 2009 (with Jeff Balchin, Greg Houston and Brendan Quach)
- Estimates of the Cost of Equity: A report for WAGN, 22 April 2009 (with Brendan Quach)
- AER's Proposed WACC Statement – Gamma: A report for the Joint Industry Associations, 30 January 2009 (with Greg Houston and Brendan Quach)
- The Value of Imputation Credits: A report for the ENA, Grid Australia and APIA, 11 September 2008 (with Greg Houston and Brendan Quach)

Consulting Experience

- HoustonKemp, 2015 -
- NERA, 2008 - 2015
- 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, 1981, 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, LaTex, Matlab, R, Visual Basic. Familiar with the SIRCA SPPR, Compustat and CRSP 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

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