AusNet Electricity Services Pty Ltd

Electricity Distribution Price Review 2016–20

Revised Regulatory Proposal

Appendix 7E: The Cost of Equity: Response to the AER's Draft Decisions for the Victorian Electricity Distributors – January 2016

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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

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Executive Summary

ActewAGL Distribution, AusNet Services, Australian Gas Networks, CitiPower, Jemena Electricity Networks, Powercor and United Energy (the networks) have asked HoustonKemp to critically review the analysis of the Australian Energy Regulator (AER) in its October and November 2015 draft decisions on the Victorian electricity distributors and ActewAGL Distribution and Australian Gas Networks and the analysis of Partington and Satchell in their October 2015 report written on behalf of the AER.[1] In particular, the networks have asked that HoustonKemp critically review the analyses of the AER and Partington and Satchell of reports submitted by NERA to the AER in April and June 2015 on behalf of ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy.[2]

NERA's June 2015 reports provide analyses of issues surrounding the cost of equity and the market risk premium (*MRP*).[3] NERA, in its June 2015 cost of equity report, emphasises that there is evidence against both the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM) and the AER's implementation of the model. In particular, there is evidence that the SL CAPM and the AER's implementation of the model significantly underestimate the returns required on low-beta assets. In contrast, there is little evidence that a naïve model, which sets the beta of every asset to one, or the Black CAPM have the same problem associated with them. The National Electricity Rules (NER) in the past constrained the equity beta of a transmission business to be one and so effectively prescribed that a naïve model be used to determine the cost of equity for a regulated transmission business.

NERA, in its June 2015 *MRP* report, provides updated estimates of the long-run *MRP* computed using historical data.[4] The report also explains why an estimate of the long-run weighted average cost of capital (*WACC*) that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will – so long as the other components of the *WACC* have been correctly computed and ignoring minor adjustments to the regulatory asset base (*RAB*) and to the evolution of prices – produce an unbiased estimate of the revenue that the market will require in any one year, in the long run, on the *RAB*.

NERA's April 2015 report examines the relation between estimates, taken from independent expert reports, of the return required on the market portfolio in excess of the 10-year Commonwealth Government Security (CGS) yield and the CGS yield.[5] NERA finds that there is a significant negative relation between the two quantities and provides an estimate of the *MRP* that uses the relation and the current 10-year CGS yield.

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[1] AER, *Preliminary decision Jemena distribution determination2016 to 2020 Attachment 3 – Rate of return*. October 2015.

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

[2] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

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.

NERA, *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.

[3] 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.

NERA, *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.

[4] NERA, *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.

[5] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

In this report we provide updates to the empirical work that NERA supplies in its February 2015 cost of equity report and April 2015 independent experts report.[6] The updates show that the results that NERA provides remain essentially unchanged when the databases that NERA uses are expanded to include more recent data. We also respond to issues that the AER and Partington and Satchell raise and conclude that the AER and its advisers have provided no reason for us to change the conclusions drawn by NERA in its April and June 2015 reports.[7]

Empirical Performance of Capital Asset Pricing Models

To begin with we provide an update of some of the results that NERA provides in its February 2015 report.[8] In particular, we provide an empirical assessment of the ability of the four models that NERA assesses to predict returns out of sample over the period January 1979 to December 2014. Evaluating the out-of-sample performance of a pricing model is an excellent way of demonstrating whether estimates of the return required on equity produced by the model are likely to be unbiased. As Nobel Prize-winner Granger and his co-author Newbold state:[9]

> 'It is important that economic forecasts be critically evaluated. An evaluation exercise, as well as providing information about the relative worth of a set of forecasts, may well suggest directions in which the forecast-generating mechanism can be improved.'

In implementing the SL CAPM, the AER states that:[10]

> 'we use the theoretical principles underpinning the Black CAPM to inform the equity beta point estimate from within our empirical range.'

The AER also states that it places some weight on foreign estimates of beta. While it sees:[11]

> 'there are inherent uncertainties when relating foreign estimates to Australian conditions'

the regulator concludes that foreign estimates of beta:[12]

> 'provide some limited support for an equity beta point estimate towards the upper end of our range.'

The AER chooses an equity beta estimate for use with the SL CAPM of 0.7 from a range of 0.4 to 0.7. This choice amounts to placing a weight of two thirds on the midpoint of the range, 0.55, and a weight of one third on one. We label a policy of placing a weight of two thirds on an unadjusted estimate of beta and one third on one and then using the SL CAPM to estimate the return required on equity a policy of using the 'AER CAPM'.

The four models that NERA assesses and that we examine are:

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[6] 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.

NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

[7] 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.

NERA, *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.

[8] 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.

[9] Granger, C. and P. Newbold, Forecasting economic time series, Academic Press, 1977, page 269.

[10] AER, *Preliminary decision Jemena distribution determination2016 to 2020 Attachment 3 – Rate of return*. October 2015, page 496.

[11] AER, *Preliminary decision Jemena distribution determination2016 to 2020 Attachment 3 – Rate of return*. October 2015, pages 127-128.

[12] AER, *Preliminary decision Jemena distribution determination2016 to 2020 Attachment 3 – Rate of return*. October 2015, page 502.

- a naïve model that sets the return required on equity to be a constant across all equities;
- the SL CAPM;
- the AER CAPM; and
- the Black CAPM.

We find, using 10 portfolios formed on the basis of past estimates of beta and monthly data from January 1979 to December 2014:

- little evidence of any bias attached to the forecasts generated by the naïve model;
- statistically significant evidence of a bias attached to the forecasts generated by the SL CAPM;
- statistically significant evidence of a bias attached to the forecasts generated by the AER CAPM;[13] and
- little evidence of any bias attached to the forecasts generated by the Black CAPM.

Our evidence indicates that the SL CAPM and the AER CAPM significantly underestimate the returns that will be generated by low-beta portfolios and overestimate 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. These out-of-sample results differ little from those that NERA provides for the period January 1979 to December 2013 in its February 2015 report.[14] We have not amended the analysis of NERA in any way as the AER and its advisers have raised no new issues about the empirical results that NERA provides in its February 2015 report and we are not aware of any issues raised by others that would lead us to amend the analysis. Thus the conclusions that we reach are the same as those reached by NERA in its February 2015 report.

The idea that there is evidence against the SL CAPM is not controversial. The AER acknowledges that:[15]

> 'the SLCAPM has weaknesses'

and the AER's advisers, Partington and Satchell, point out that:[16]

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

Satchell, in work with Muijsson and Fishwick, is more explicit and states that:[17]

> '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.'

Our results indicate, however, that the adjustments that the AER makes in implementing the SL CAPM are insufficient to eliminate, or even render insignificant, the bias associated with the model. We stress that the adjustments that the AER makes are not in any formal quantitative way linked to the evidence that exists against the model. They are instead linked to the uncertainty that the AER has about what an unadjusted value for the equity beta of an NSP should be. It is, therefore, not surprising that empirically the adjustments do not work. While we have conducted tests to determine whether the adjustments that the AER makes are sufficient to eliminate or render insignificant the bias that is associated with the SL CAPM, the AER itself has

[13] We find that these results are not sensitive to whether we presume that the AER follows a policy of upwardly adjusting an unadjusted estimate of 0.50, 0.55 or 0.60 to an adjusted estimate of 0.70.

[14] 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.

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

[16] 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.

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

not done so. We conclude that the AER has chosen to use a model to compute an estimate of the return required on the equity of an NSP that delivers estimates of the return that exhibit a statistically significant downward bias.

Partington and Satchell 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:[18]

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

In our empirical work, we use 622 monthly estimates of the zero-beta premium from March 1963 to November 2014. 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 are 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. Again, the evidence that we provide 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. 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:[19]

> '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 both NERA and SFG suggest that an estimate of the zero-beta rate be 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 we provide 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 SL CAPM or AER 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 and Partington raise.[20] 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):
>
> > Identification: as $\beta i \rightarrow 1$, 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.

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

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

[20] 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.

> 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 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.[21]

We note, in addition, that while Beaulieu, Dufour and Khalaf 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. Like NERA and SFG, 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.

Historical Estimates of the *MRP*

In its June 2015 report, NERA provides estimates of the long-run *MRP* that use annual data from 1883 through to 2014.[22] It finds that an estimate of the *MRP* is 6.55 per cent per annum and that the standard error attached to the estimate is 1.44 per cent per annum. This estimate uses an assumption that the market places a value of 35 cents on a dollar of imputation credits distributed.[23, 24]

NERA's data, like the data that the AER uses, employs a series of yields that Lamberton (1961) provides.[25] Brailsford, Handley and Maheswaran (2008) suggest that the series that Lamberton provides overstates the yield on the Commercial and Industrial/All Ordinaries price series that Lamberton (1958) also supplies.[26]

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[21] 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.

[22] NERA, *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.

[23] NERA, like Brailsford, Handley and Maheswaran (2008, 2012), uses imputation credit yields for December of each year taken from the Australian Taxation Office (ATO). At the time that NERA's June *MRP* report was written the ATO had yet to update its data beyond September 2014 and so NERA used the credit yield of 1.43 per cent per annum that the ATO reported for September 2014 in place of a December 2014 yield. The ATO has now provided a credit yield for December 2014 and it too is 1.43 per cent per annum and so we have not revised NERA's estimates in any way.

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

Brailsford, T., J. Handley and K. Maheswaran, *The historical equity risk premium in Australia: Post-GFC and 128 years of data*, Accounting and Finance, 2012, pages 237-247.

[24] This value is the value laid down by the ACT in a decision on the market value of a one-dollar credit distributed. See

ACT, Application by Energex Limited (Gamma) (No 5) [2011] ACompT9, May 2011.

A value of 60 cents, on the other hand, lies within the range of values that the AER employs. If a value of 60 cents were used, then an estimate of the *MRP* would be 6.64 per cent per annum. See:

AER, *Preliminary decision Jemena distribution determination 2016–20: Attachment 4: Value of imputation credits*, October 2015, page 18.

[25] Lamberton, D., *Ordinary share yields: A new statistical series*, Sydney Stock Exchange Official Gazette, 14 July 1961.

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

Lamberton, D., *Security prices and yields*, Sydney Stock Exchange Official Gazette, 14 July 1958.

Lamberton, D., *Share price indices in Australia*, Sydney: Law Book Company, 1958.

Lamberton, D., *Some statistics of security prices and yields in the Sydney market, 1875-1955*, Economic Record, 1958, pages 253-259.

Lamberton's yields, provided for the Sydney Stock Exchange (SSE), are equally weighted, use only stocks that pay dividends and use more stocks than do the price indices – which were also constructed by Lamberton for the SSE. The evidence that NERA provides in its June 2015 report suggests that some adjustment should be made to Lamberton's yield data but that the adjustment should be smaller than the adjustment that Brailsford, Handley and Maheswaran believe to be appropriate.[27] NERA reaches this conclusion by examining the original sources that Lamberton uses for the quarters ending in December 1883, December 1891, December 1901, December 1911, December 1921, December 1931, December 1941, and December 1951 and by using Brailsford, Handley and Maheswaran's analysis of yield data for February 1966. The use of NERA's adjustment in place of the adjustment that Brailsford, Handley and Maheswaran employ adds 37 basis points to an estimate of the *MRP* computed using annual data from 1883 to 2014.

In its draft decisions, the AER makes four points. First, the AER states that:[28]

> 'it was the ASX (at that time, the SSE) that made the adjustment to the earlier data, and it is the ASX's adjustment that NERA is disputing'

and provides the following quote from an article authored by Fitzherbert (2006) that states that:[29]

> 'the ASX Statistician (1996) compiled a quarterly accumulation index dating back to 1882 which corresponds with the ASX All Ordinaries accumulation index, which has been calculated daily since 1979.'

Fitzherbert has informed us that the ASX Statistician to which he refers is a person and not a publication and we are not aware of any ASX or SSE publication that uses the adjustment that the AER and Brailsford, Handley and Maheswaran employ. We note further that the ASX has made clear in writing that it holds no view as to whether or how Lamberton's series of yields should be adjusted and we believe, quite reasonably, that the most reliable source for what view the ASX holds on the matter is the ASX itself.[30]

Second, the AER states that the evidence that Fitzherbert (2006) provides supports the use of the adjustment that Brailsford, Handley and Maheswaran (2008) employ.[31] Fitzherbert states that:[32]

> 'Over the period 1955–1979 (excluding 1961–1965), there was an average difference of 2.3% between the market-weighted average dividend yield of the stocks in the Melbourne 50 Leaders index and the unweighted average of all stocks calculated by the Sydney exchange.'

We note that Fitzherbert does not use data from before 1955 to assess what adjustment to Lamberton's yield data would make sense and that relying on an adjustment factor that uses only data from 1955 onwards is likely to mislead.

Third, the AER states that:[33]

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[27] NERA, *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.

[28] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 380.

[29] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, page 20.

[30] https://www.aer.gov.au/system/files/United%20Energy%20-%20Submission%20on%20JGN%20draft%20decision%20-%20ASX%20letter%20to%20UED%20-%2027%20March%202015.pdf

[31] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

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

Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, pages 20-25.

[32] Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, page 23.

[33] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

> 'it is not reasonable to draw a conclusion about the adjustment factor for 300 data points from a sample of eight of those data points.'

We note that NERA (2013, 2015) examines the original sources that Lamberton (1958) uses for the quarters ending in December 1883, December 1891, December 1901, December 1911, December 1921, December 1931, December 1941, and December 1951 and, in addition, uses Brailsford, Handley and Maheswaran's (2008) analysis of yield data for February 1966.[34] NERA therefore uses nine and not eight data points. Regardless, however, it is difficult to see that the analysis by Brailsford, Handley and Maheswaran of a single month in 1966 or Fitzherbert's (2006) analysis of data from 1955 to 1979 will provide a more reliable guide to what adjustments to Lamberton's yield series one should make than an examination of eight or nine data points spread evenly over the entire sample period – which again starts in 1883. [35]

Fourth, the AER states that the earlier data are of a lower quality than the later data, ie:[36]

> 'there are significant problems with the earlier data, regardless of which adjustment is used.'

While a problem with the earlier data may be that it relies on a relatively small number of stocks, there are significant problems with relying solely on the later data. The most significant problem with relying solely on the later data is that the estimates of the *MRP* produced are imprecise. The AER does not show this to be a problem in its decisions because it does not report the standard errors of its estimates. We recommend, as NERA does in its June 2015 report, that the AER report the standard errors of its *MRP* estimates. We note that Partington and Satchell endorse this recommendation.[37]

Arithmetic versus Geometric Averaging

In a March 2012 report NERA emphasises that an estimate of the long-run *WACC* that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will – so long as the other components of the *WACC* have been correctly computed and ignoring minor adjustments to the *RAB* and to the evolution of prices – produce an unbiased estimate of the revenue that the market will require in any one year, in the long run, on the *RAB*.[38] NERA also emphasises in the report that, in contrast, an estimate of the *WACC* that is in part based on an estimate of the *MRP* that places a positive weight on the geometric mean of a sample of annual excess returns to the market portfolio will produce a downwardly biased estimate of the return that the market requires in any one year.

While an estimate of the *WACC* compounded over more than one year, based on the arithmetic mean of a sample of annual excess returns to the market portfolio, will be biased, the AER, aside from some minor adjustments to the *RAB* and to the evolution of prices over the regulatory period, never compounds the *WACC*

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

Lamberton, D., *Security prices and yields*, Sydney Stock Exchange Official Gazette, 14 July 1958.

Lamberton, D., *Share price indices in Australia*, Sydney: Law Book Company, 1958.

Lamberton, D., *Some statistics of security prices and yields in the Sydney market, 1875-1955*, Economic Record, 1958, pages 253-259.

NERA, *The market, size and value premiums: A report for the ENA*, June 2013.

NERA, *The market risk premium: Analysis in response to the AER's Draft Rate of Return Guidelines*, October 2013.

NERA, *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.

[35] Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, pages 20-25.

[36] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 383.

[37] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 46.

[38] NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, pages 3-16 and pages 57-59.

over more than one year.[39] Thus we recommend that for long-run estimates of the *MRP* the AER should rely solely on estimates that use arithmetic means and that the AER should place no weight on estimates that use geometric means. An estimate of the *MRP* that relies solely on estimates that use arithmetic means will provide a materially better estimate than an estimate that relies either fully or in part on geometric means.

We note that in independent advice provided at the request of the Queensland Competition Authority in July 2012, Lally, an adviser to the AER, reaches the same conclusion as we do and states that:[40]

> 'The AER's belief that geometric averages are useful apparently arises from a belief that there is a compounding effect in their regulatory process (AER, 2012, Appendix A.2.1), and therefore the analysis of Blume (1974) and Jacquier et al (2003) applies. However, I do not think that there is any such compounding effect in regulatory situations and the absence of a compounding effect leads to a preference for the arithmetic mean over the geometric mean.'
>
> 'If historical average returns are used, they should be arithmetic rather than geometric averages.'

The AER does not follow the advice that Lally provides in July 2012 and the advice provided by NERA in March 2012, February 2013, June 2013, February 2015 and June 2015 and instead relies on advice provided by McKenzie and Partington in December 2011 and February 2012 and Partington and Satchell in May 2015 and October 2015.[41] McKenzie and Partington and Partington and Satchell note that an estimate of the *WACC*, compounded over more than one year, that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will be biased. McKenzie and Partington do not point to where in the regulatory process they believe the AER compounds an estimate of the *WACC* while Partington and Satchell rely on an argument that the AER made in 2012 that was shortly thereafter shown to be incorrect, separately, by the AER's adviser, Lally, and by NERA.

Partington and Satchell state in their October 2015 report that:[42]

> 'the point of setting the regulatory return is to select a rate at which new investment is a zero NPV activity. Underlying the rate setting, therefore, is the concept that the return is compounded.'

Lally, in his July 2012 report, and NERA, in its February 2013, June 2013, February 2015 and June 2015 reports, show that, while in ensuring the zero-NPV condition is satisfied the unknown discount rate or true *WACC* will be compounded, the allowed rate applied to the *RAB*, that is, an estimate of the *WACC*, will not

[39] NERA's March 2012 report details the minor adjustments that the AER makes that involve compounding. These have to do with the timing of capital expenditure, difference between actual and forecast capital expenditure and the smoothing of prices.

[40] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 31-32.

[41] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 31-32.

McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011, pages 10-12.

McKenzie, M. and G. Partington, *Report to the AER: Supplementary report on the equity market risk premium*, SIRCA Limited, 22 February 2012, pages 5-9.

NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, pages 3-16 and pages 57-59.

NERA, *The cost of equity for a regulated energy utility: A report for Multinet*, February 2013, pages 48-53.

NERA, *The market, size and value premiums: A report for the ENA*, June 2013, pages 12-24.

NERA, *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, pages 25-30.

NERA, *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, pages 14-28.

Partington, G. and S. Satchell, *Report to the AER: Return of (sic) equity and comment on submissions in relation to JGN*, May 2015, pages 16-17.

Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 44-46.

[42] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 44.

be compounded. Thus Lally concludes that an estimate of the *WACC* is never compounded and that for the zero-NPV condition to be satisfied:[43]

> 'the expected value of the annual regulatory cost of capital must be equal to the true (but unknown) annual cost of capital.'
>
> 'The geometric mean fails this test while the arithmetic mean will satisfy it if annual returns are independent and drawn from the same distribution.'

NERA similarly concludes in its February 2013 report that:[44]

> 'we emphasise, as we make clear in our March 2012 report and Lally (2012) makes clear, that the AER never – ignoring minor adjustments to the *RAB* and to the evolution of prices – compounds an estimate of the *MRP*.
>
> 'while the utility's true *WACC* is compounded, the *WACC* is a parameter and not an estimate. In other words, the true *WACC* is not a random variable.'

The arithmetic mean of a sample of returns will provide an unbiased estimate of the unconditional expected return to an asset over a single period so long as the expectation exists.[45] In contrast, the geometric mean of a sample of returns will generally provide a downwardly biased estimate of the unconditional expected return to an asset over a single period. Partington and Satchell, in their October 2015 report, make the surprising claim that if the gross return to an asset is lognormally and independently and identically distributed through time, then the arithmetic mean of a sample of gross returns to the asset will provide an upwardly biased estimator of the expected gross return to the asset over a single period while the geometric mean will, for large samples, provide an unbiased estimator.[46] We show this claim to be incorrect.

Evidence from Independent Expert Reports

We present evidence on the *MRP* adopted by independent experts relative to the 10-year CGS yield in reports published between 1 January 2008 and 30 November 2015 and evidence on the relation over time between the *MRP* adopted by experts and the CGS yield.

An examination of the data reveals that experts often add a firm-specific premium to the cost of equity and McKenzie and Partington (2014) argue that many of these premiums may be a way of adjusting for factors that should be reflected in forecasts of cash flows.[47] We exclude these premiums from our analysis.

Occasionally, an independent expert will set a value for the *MRP*, calculate a value for the cost of equity and then subsequently revise the *WACC*. When the revision exceeds 25 basis points per annum, we examine the expert's report to determine whether there is clear evidence that the expert is raising or lowering his or her assessment of the risk-free rate or is adding or subtracting a premium for what he or she perceives to be higher or lower levels of market-wide risk. Where there is evidence, we record both unadjusted and adjusted values for the *MRP*. For those projects and reports where adjustments are made but they are not for reasons of this kind, we compute only unadjusted estimates of the *MRP*.

Where an expert evaluates more than one project we compute for each project an unadjusted estimate of the mean return to the market and, in addition, adjusted estimates. The unadjusted estimates never differ across

[43] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, page 32.

[44] NERA, *The cost of equity for a regulated energy utility: A report for Multinet*, February 2013, pages 50, 52-53.

[45] The unconditional expectation of a random variable is the mean of its marginal probability distribution. The conditional expectation of a random variable, on the other hand, is the mean of the probability distribution of a random variable conditional on some other variable or variables. Our focus here is on unconditional expectations.

There are random variables which have no means. The mathematical expectation of a Cauchy random variable, for example, does not exist.

[46] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 44-46.

[47] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014, page 42.

the projects that a report values but the adjusted estimates often do. In our empirical work, we use data for only one project per report and employ as a criterion that the project selected have the lowest adjusted return to the market associated with it of the projects considered by the report. Thus we use a conservative selection criterion.

McKenzie and Partington (2014) correctly point out that experts typically author many reports and in these reports they may make similar choices.[48] So while the experts themselves may be independent, the reports that they author need not be independent of one another. We take into account the impact of the dependence that may exist on the standard errors that we compute using a random effects model.

We find that across all reports that experts on average set the *MRP* to be 7.16 (7.60) per cent per annum relative to the 10-year CGS yield inclusive of a value assigned to imputation credits – assuming a value for a one-dollar credit distributed of 0.35 (0.60) – but exclusive of any final revisions made by experts.

We also find a significant negative relation between the *MRP* adopted by experts relative to the 10-year CGS yield and the CGS yield and that this negative relation is primarily a result of a tendency for experts to use a risk-free rate that exceeds the CGS yield when the CGS yield is low. The annual effective 10-year CGS yield on average over the 20 business days from 3 September 2015 to 30 September 2015 is 2.75 per cent per annum. An estimate of the *MRP* that uses this yield and the evidence of a negative relation is 7.58 (8.02) per cent per annum, inclusive of a value assigned to imputation credits distributed – assuming a value for a one-dollar credit distributed of 0.35 (0.60) – but exclusive of any final revisions made by experts. An estimate of the *MRP* that uses the yield of 2.75 per cent per annum and the evidence of a negative relation is either 7.94 or 7.99 (8.38 or 8.43) per cent per annum, inclusive of a value assigned to imputation credits distributed – assuming a value for a one-dollar credit distributed of 0.35 (0.60) – and inclusive of any final revisions made by experts, depending on how one interprets the revisions.

The AER, in its draft decisions, raises a number of issues about the use of independent expert reports.

First, the AER states that:[49]

> 'It is not clear why NERA considers a valuer's estimate of (sic) market risk premium should be used to determine the valuer's estimated return on the market but should not be used to determine the valuer's estimated market risk premium. NERA instead prefers to use a measure of (sic) market risk premium defined as the valuer's estimated return on the market less the yield on Commonwealth government securities.'

NERA computes the *MRP* that an independent expert applies as the difference between the return to the market that the expert expects to see less the 10-year CGS yield because this is how the AER measures the *MRP*. The *MRP* is the difference between the expected return to the market and the risk-free rate and the AER uses the 10-year CGS yield to measure the risk-free rate.[50] Thus the AER measures the *MRP* as the difference between the expected return to the market and the 10-year CGS yield. NERA computes the *MRP* that an expert applies in exactly the same way.

Second, the AER states that:[51]

> 'It is not clear that valuation reports using risk free rate estimates that exceed yields on Commonwealth government securities is a widespread and persistent practice.'

[48] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014, page 46.

[49] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 535.

[50] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 33.

[51] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 536.

This assertion is not supported by the evidence that we and NERA provide.[52] We find a negative relation between the difference between the risk-free rate that an expert uses and the 10-year CGS yield and the CGS yield. This evidence is statistically significant at conventional levels whether or not inference is based on ordinary least squares standard errors, random effects standard errors or generalised method of moments standard errors. If using a risk-free rate that exceeds the CGS yield were not a widespread practice, one would not find evidence of this kind.

Third, the AER states that there is:[53]

> 'the possibility that valuers increase risk free rate estimates to reflect differences in the investment horizon relevant to the valuation report and the term of the Commonwealth government security used to proxy the risk free rate.'

The AER also provides an extract from a recent valuation report authored by KPMG that states that:[54]

> 'In Australia, the spot yield to maturity of 10 year Government Bonds has traditionally been accepted as a proxy for the risk free rate in determining a cost of equity under the CAPM. Further, the market in 10 year Government Bonds is liquid such that, in our view, the current yield on Government Bonds represents the best indicator of the risk free opportunity cost of the assets for the forthcoming 10 year period at any particular point in time.
>
> In our view, it is appropriate to take into account both the current yield on 10 year Australian Government Bonds, as well as the longer term expected yield in order to calculate a blended risk free rate over a time horizon appropriate to the underlying business operations of Prima. In this regard, we note that long term estimates of the yield on 10 year Australian Government Bonds approximated 5.5%. Adopting the spot yield of 2.64% for a period of 10 years, followed by 5.5% from year 11 onwards results in a blended risk free rate estimate of 4.3%.'

The AER's contention in a nutshell is that a steeper slope to the term structure will lead experts on average to use proxies for the risk-free rate that are more likely to exceed the 10-year CGS yield and a term structure that is less steeply sloped will lead experts on average to use proxies for the risk-free rate that are more likely to fall below the 10-year CGS yield. We examine:

- whether empirically the AER's argument can explain the magnitude of the adjustments that some experts make to the risk-free rate; and
- whether there is evidence that experts who make large adjustments cite a steeply sloped term structure as a reason for making the adjustments.

We examine numerical examples drawn from reports written by experts in which large adjustments are made to show that the AER's argument does not explain the adjustments that some experts make to the risk-free rate. We show, for example, that the duration of the Prima cash flows that KPMG values is too low for the AER's term structure argument to make sense.

We also examine the 25 reports in which an expert makes an adjustment to the risk-free rate of more than 100 basis points. One of the earlier reports, published on 24 September 2012, is authored by KPMG and this report states that:[55]

> 'Recent market volatility and risk aversion by investors, driven by macro-economic uncertainty, particularly in Europe, has contributed to bond yields trading at historical lows. Further, market evidence indicates that bond yields and the MRP are strongly inversely correlated. In this context, it is important that any assessment of the risk-free rate should be made with respect to the position

[52] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

[53] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 536.

[54] KPMG, *Prima BioMed Limited: Independent Expert Report*, 22 June 2015, page 60.

[55] KPMG, *Consolidated Media Holdings Limited: Independent Expert Report*, 24 September 2012, pages 91-92.

> adopted in deriving the MRP, and there are two relevant options available when undertaking this exercise:
>
> - adopt a historical MRP as a proxy for the expected MRP and adjust the spot risk-free rate to take into account the relationship highlighted above; or
> - adopt the spot risk-free rate and adjust the MRP for the perceived additional risks attaching to equity investments implicit from historically low (or high as the case may be) risk-free rates to reflect the current investment environment and the inverse relationship between the two variables.
>
> For the purposes of our analysis, we have adopted the former approach and applied a historical estimate of the MRP and adjusted the risk-free rate accordingly.'

KPMG is clear here that it believes that bond yields and the *MRP* are strongly negatively related and that it views adjustments to the CGS yield and adjustments to the *MRP* as two alternative methods for dealing with the problems arising from yields that are trading at historical lows.

Other experts provide a similar rationale for using a value for the risk-free rate that sits above the 10-year CGS yield. For example, Lonergan and Edwards state in their 25 October 2012 report that:[56]

> 'The currently prevailing 10 year Commonwealth Government bond rate is well below historical levels and reflects, inter alia, the weak outlook for global economic growth (and its impact on the outlook for the Australian economy) and the effect of quantitative easing measures by major overseas central banks. At the same time spreads have generally increased to offset the impact of the lower risk-free rate. Accordingly, in our view the application of current (low) government bond yields and long-term average market risk premiums is inappropriate in the context of determining long-term required equity rates of return (discount rates).'
>
> 'As it is difficult to reliably measure short-term movements in the market risk premium we have therefore increased the risk-free rate for the purpose of estimating required equity rates of return only.'

As another example, Ernst and Young state in their 7 November 2012 report that:[57]

> 'We believe that the current risk free rate (usually estimated with reference to the 10 year Government bond rate) is at historically low levels. Most market observers regard this as inconsistent with current share prices, the observed volatility in markets and general economic uncertainty. In response, many valuers have either used a normalised risk free rate, increased their estimates of the market risk premium or have included an additional risk factor in their calculations of the cost of equity. Our preference is to normalise the risk free rate to best reflect the longer term position.'

Aside from KPMG, there is only one other firm of experts that has published a report that might be interpreted as suggesting that it uses a risk-free rate that is at least 100 basis points higher than the 10-year CGS yield because of concerns over the slope of the term structure. In the only report that HanrickCurran has written that is in our database, the firm of experts states that:[58]

> 'The current risk free rate (spot rate) is at or near an historical low and in view of the long term nature of the assets being valued is unrepresentative of the risk free rate.'

An examination of HanrickCurran's report, however, casts doubt on the idea that the expert chooses a higher value for the risk-free rate solely because of concerns about the slope of the term structure. As with the KPMG report on Prima, the duration of the cash flows is too low for the term structure hypothesis to explain the magnitude of the adjustment that HanrickCurran makes.

[56] Lonergan & Edwards, *Stanmore Coal: Independent Expert Report*, 25 October 2012, page 46.

[57] Ernst & Young, *Integra Mining: Independent Expert Report*, 7 November 2012, page 84.

[58] HanrickCurran, *PAYCE Consolidated Limited: Independent Expert Report*, 2 April 2015, page 62.

Finally, Partington and Satchell note that some firms of experts write more reports than others and suggest that instead of placing an equal weight on each report, less weight should be placed on reports written by firms of experts who write many reports and more weight should be placed on firms that write few reports.[59] In particular, they argue that firms that write many reports may employ estimates that are no better than firms that write few reports.

It is not clear that firms that write many reports employ estimates that are no better than firms that write few reports and it is also not clear that estimates that place an equal weight on each firm of experts rather than on each report will be more reliable. Nevertheless, we report the means computed across the 23 firms of experts of:

- the risk-free rate chosen by an independent expert;
- the 10-year CGS yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls; and
- the *MRP* chosen by an independent expert relative to the risk-free rate chosen by the expert.

To compute these means, first, for each firm of experts and for each variable, we compute the mean of the variable across all reports written by the firm and then second, for each variable, we compute the mean of the 23 firm means. Computing the means in this way widens the gap between the mean of the risk-free rate chosen by a firm of experts and the mean of the CGS yield. Computing the means in this way also raises an estimate of the *MRP* computed relative to the risk-free rate chosen by an expert.

[59] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 32-33.

1. Introduction

ActewAGL Distribution, AusNet Services, Australian Gas Networks, CitiPower, Jemena Electricity Networks, Powercor and United Energy (the networks) have asked HoustonKemp to critically review the analysis of the Australian Energy Regulator (AER) in its October and November 2015 draft decisions on the Victorian electricity distributors and ActewAGL Distribution and Australian Gas Networks and the analysis of Partington and Satchell in their October 2015 report written on behalf of the AER.[60] In particular, the networks have asked that HoustonKemp critically review the analyses of the AER and Partington and Satchell of reports submitted by NERA to the AER in April 2015 and June 2015 on behalf of ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy.[61]

NERA's June 2015 reports provide analyses of issues surrounding the cost of equity and the market risk premium (*MRP*).[62] NERA, in its June 2015 cost of equity report, emphasises that there is evidence against both the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM) and the AER's implementation of the model. In particular, there is evidence that the SL CAPM and the AER's implementation of the model significantly underestimate the returns required on low-beta assets. In contrast, there is little evidence that a naïve model, which sets the beta of every asset to one, or the Black CAPM have the same problem associated with them. The National Electricity Rules (NER) in the past constrained the equity beta of a transmission business to be one and so effectively prescribed that a naïve model be used to determine the cost of equity for a regulated transmission business.

NERA, in its June 2015 *MRP* report, provides updated estimates of the long-run *MRP* computed using historical data. The report also explains why an estimate of the long-run weighted average cost of capital (*WACC*) that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will – so long as the other components of the *WACC* have been correctly computed and ignoring minor adjustments to the regulatory asset base (*RAB*) and to the evolution of prices – produce an unbiased estimate of the revenue that the market will require in any one year, in the long run, on the *RAB*.[63]

NERA's April 2015 report examines the relation between estimates, taken from independent expert reports, of the return required on the market portfolio in excess of the 10-year Commonwealth Government Security (CGS) yield and the CGS yield.[64] NERA finds that there is a significant negative relation between the two quantities and provides an estimate of the *MRP* that uses the relation and the current 10-year CGS yield.

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[60] AER, *Preliminary decision Jemena distribution determination2016 to 2020 Attachment 3 – Rate of return*. October 2015.

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

[61] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

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.

NERA, *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.

[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.

NERA, *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.

[63] NERA, *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.

[64] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015.

The networks have asked HoustonKemp to provide a review and critique of the AER preliminary decision and the report from Partington and Satchell, including as to:

(a) whether there is evidence that the SLCAPM is biased and, if so, what effect the bias has and what, if any, adjustments could be made to offset this bias;

(b) whether independent experts adjust the SLCAPM for this, or any other, bias and, if so, the nature of any such adjustment;

(c) whether evidence from independent expert reports should, and, if so how such evidence could, be used to inform the estimate of the return on equity;

(d) the use made of the paper by Kan, Robotti, and Shanken (2013); and

(e) any other matter that the Expert considers is relevant to estimating the return on equity arising from the preliminary decision or the Partington and Satchell report.

The rest of the report is organised as follows:

- section 2 responds to issues raised by the AER and Partington and Satchell about the empirical performance of capital asset pricing models;
- section 3 responds to issues that the AER and Partington and Satchell raise about estimates of the long-run *MRP*; and
- section 4 responds to issues that the AER and Partington and Satchell raise about the relation between estimates, taken from independent expert reports, of the return required on the market portfolio in excess of the 10-year CGS yield and the CGS yield.

In addition:

- Appendix A provides the terms of reference for this report;
- Appendix B provides a copy of the Federal Court of Australia's *Guidelines for Expert Witnesses in Proceeding in the Federal Court of Australia*; and
- Appendix C provides the curriculum vitae of the author of the report.

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 ActewAGL Distribution, AusNet Services, Australian Gas Networks, CitiPower, Jemena Electricity Networks, Powercor and United Energy in the past. However, I remain at arm's length, and as an independent consultant.

2. Empirical Performance of Capital Asset Pricing Models

Investors will only invest in regulated energy utilities if the return that they can expect to earn is sufficient to attract capital. The focus of this report is on determining an appropriate estimate of the return that investors expect to earn on equity. Equity is risky and with this risk comes the expectation of a reward. Measuring the reward, however, is not straightforward. The return that the market requires on equity is not something that one can easily observe. In practice, estimating the return that the market requires on the equity of a regulated energy utility requires one use either a capital asset pricing model or a method for extracting estimates of the return from market prices.

Clauses 6.5.2 (b) and 6A.6.2 (b) of the old (prior to 28 November 2012) NER prescribed that the SL CAPM be used to determine the return required on the equity of a distribution NSP and the return required on the equity of a transmission NSP, respectively. Clause 6A.6.2 (b) of the rules originally prescribed, in addition, that an equity beta of one be used for a transmission NSP. Similarly, Clause 87 (b) of the old National Gas Rules (NGS) prescribed that:

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

Clauses 6.5.2 and 6A.6.2 of the new (from 29 November 2012 onwards) NER and Clause 87 (5) of the new NGR do not prescribe that the SL CAPM be used to determine the return required on the equity of an NSP but instead state that:

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

So under the new NER and NGR the AER 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 this section, we provide an update of some of the results that NERA provides in a February 2015 report.[65] In particular, we provide an empirical assessment of the ability of four models to predict returns over the period January 1979 to December 2014. Evaluating the out-of-sample performance of a pricing model is an excellent way of demonstrating whether estimates of the return required on equity produced using the model are likely to be unbiased. As Nobel Prize-winner Granger and his co-author Newbold state in their text on forecasting economic time series:[66]

> 'It is important that economic forecasts be critically evaluated. An evaluation exercise, as well as providing information about the relative worth of a set of forecasts, may well suggest directions in which the forecast-generating mechanism can be improved.'

The four models that we examine are:

- a naïve model that sets the return required on equity to be a constant across all equities;
- the SL CAPM;
- the AER's implementation of the SL CAPM, which involves some adjustments to the traditional form of the model (specifically, as discussed below, the AER indicates that it has adjusted estimates of the equity beta of an NSP to account for the theory underlying the Black CAPM); and

[65] 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.

[66] Granger, C. and P. Newbold, *Forecasting economic time series*, Academic Press, 1977, page 269.

- the Black CAPM.

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 that there is empirical evidence against the SL CAPM.[67] Thus finance academics use the model 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.

A naïve model that sets the return required on equity to be a constant across all equities resembles the model originally prescribed by the NER for transmission NSPs. 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.

In using the SL CAPM, the AER makes a number of adjustments. In particular, the AER states that:[68]

> 'In informing the equity beta point estimate (from within the empirical range), we consider evidence from other relevant material. This includes international empirical estimates … and the theoretical underpinnings of the Black CAPM.'

The AER chooses an equity beta estimate for use with the SL CAPM of 0.7 from a range of 0.4 to 0.7. This choice amounts to placing a weight of two thirds on the midpoint of this range, 0.55, and a weight of one third on one. We label a policy of placing a weight of two thirds on an unadjusted estimate of beta and one third on one and then using the SL CAPM to estimate the return required on equity a policy of using the 'AER CAPM'.[69]

Using 10 portfolios formed on the basis of past estimates of beta and monthly data from January 1979 to December 2014, we find:

- little evidence of any bias attached to the forecasts generated by the naïve model;
- statistically significant evidence of a bias attached to the forecasts generated by the SL CAPM;
- statistically significant evidence of a bias attached to the forecasts generated by the AER CAPM; and
- little evidence of any bias attached to the forecasts generated by the Black CAPM.

The evidence indicates that the SL CAPM and the AER CAPM significantly underestimate the returns that will be generated by low-beta portfolios and overestimate the returns that will be generated by high-beta

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

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 AER works.

Since our interest is in whether the empirical version of the SL CAPM applied by the AER 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 AER 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.

[68] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 37.

[69] The choice of label is unimportant. What is important is that we specify clearly a method that a regulator might use in estimating a return required on equity for a regulated electricity NSP and that we use time series of returns to evaluate the method. Methods that we cannot specify clearly, we cannot evaluate. We cannot, for example, evaluate the use by a regulator of its discretion in a way that is not specified and in a way that may vary through time.

portfolios. The extent to which they underestimate the returns that will be generated by low-beta portfolios is both statistically and economically significant. The empirical assessment of the four models that we provide here represents an update of the out-of-sample results that NERA provides in its February 2015 report and the results that we provide differ little, not surprisingly, from the results that NERA provides.[70] We have not amended the analysis of NERA in any way as the AER and its advisers have raised no new issues about the empirical results that NERA provides in its February 2015 report and we are not aware of any issues raised by others that would lead us to amend the analysis. Thus the conclusions that we reach are the same as those reached by NERA in its February 2015 report.

We emphasise that the idea that there is evidence against the SL CAPM is not controversial. The AER acknowledges that:[71]

> 'the SLCAPM has weaknesses.'

The AER's advisers, Partington and Satchell, point out that:[72]

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

Satchell in work with Muijsson and Fishwick states that:[73]

> '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.'

and the AER's adviser Handley notes that:[74]

> 'It is well known that an apparent weakness of the Sharpe-CAPM is the empirical finding, for example by Black, Jensen and Scholes (1972) and Fama and French (2004), that the relation between beta and average stock returns is too flat compared to what would otherwise be predicted by the Sharpe-CAPM – a result often referred to as the low beta bias.'

Our results also indicate, however, that the adjustments that the AER makes in implementing the SL CAPM are insufficient to eliminate, or even render insignificant, the bias associated with the model. We stress below that the adjustments that the AER makes are not in any formal quantitative way linked to the evidence that exists against the model. They are instead linked to the uncertainty that the AER has about what an unadjusted value for the equity beta of an NSP should be. It is, therefore, not surprising that empirically the adjustments do not work. We also stress below that while we have conducted tests to determine whether the adjustments that the AER makes are sufficient to eliminate or render insignificant the bias that is associated with the SL CAPM, the AER itself has not done so. We conclude that the AER has chosen to use a model to compute an estimate of the return required on the equity of an NSP that delivers estimates of the return that exhibit a statistically significant downward bias.

The AER and its advisers have characterised the Black CAPM as a more difficult model to use than the SL CAPM because in using the Black CAPM not only must one estimate the equity beta of a firm and the *MRP* but one must also estimate the return required on a zero-beta portfolio.[75] One could also characterise the SL

[70] 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.

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

[72] 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.

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

[74] Handley, J.C., *Advice on the rate of return for the 2015 AER Energy Network Determination for Jemena Gas Networks*, 20 May 2015, page 5.

[75] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, pages 307-313.
Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 25-26.

CAPM, though, as a more difficult model to use than a naïve model because in using the SL CAPM not only must one estimate the *MRP* but one must also estimate the equity beta of a firm. One might then ask, as the AER and its advisers have not, whether it is in fact worthwhile moving from a simple model, a naïve model, which was effectively used for transmission electricity NSPs in the past (because the old NER prescribed that an equity beta of one be employed) and which generates estimates of the return required on equity that are unbiased, to a complex model, the SL CAPM, which generates biased estimates.

2.1 Importance of Estimates of the Cost of Equity

In its March 2015 report, NERA emphasises that 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:[76, 77]

> '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 AER not use a model that, empirically, delivers biased estimates.

2.2 AER's Approach

NERA makes clear in a March 2015 report and the AER and its advisers acknowledge that there is evidence against the SL CAPM.[78] The task that faces the AER, therefore, given that it uses the SL CAPM, is to provide a way of making an adjustment or adjustments to the parameters that it chooses for the model so as to ensure that the estimate of the return required on the equity of an NSP that it produces is unbiased – or at

[76] 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.

[77] 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.

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

Handley, J.C., *Advice on the rate of return for the 2015 AER Energy Network Determination for Jemena Gas Networks*, 20 May 2015, page 5.

NERA, *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, pages 22-45.

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.

least does not exhibit a bias that is statistically significant. Clearly, to establish that any adjustment or adjustments that the AER makes are sufficient to render an estimate of the return required on the equity of an NSP unbiased requires some sort of empirical assessment. We, like NERA in its February 2015 report, provide such an assessment below. The AER, in contrast, provides no such assessment.[79]

The AER states that it uses:[80]

> 'the theoretical principles underpinning the Black CAPM to inform the equity beta point estimate from within our empirical range.'

To understand how a regulator might use the principles underpinning the Black CAPM, recall that the SL CAPM implies that:

$$\mathrm{E}_{t-1}(z_{jt}) = \beta_{jt}\mathrm{E}_{t-1}(z_{mt}) \qquad (1)$$

where:

$\mathrm{E}_{t-1}(z_{jt})$ = the mean return on risky asset j in excess of the risk-free rate from $t-1$ to t conditional on what is known at $t-1$;

$\mathrm{E}_{t-1}(z_{mt})$ = the mean return to the market portfolio of risky assets in excess of the risk-free rate conditional on what is known at $t-1$

and

$$\beta_{jt} = \frac{\mathrm{Cov}_{t-1}(z_{jt}, z_{mt})}{\sigma^2_{t-1}(z_{mt})}, \qquad (2)$$

where:

$\mathrm{Cov}_{t-1}(z_{jt}, z_{mt})$ = the covariance between z_{jt} and z_{mt} conditional on what is known at $t-1$; and

$\sigma^2_{t-1}(z_{mt})$ = the variance of z_{mt} conditional on what is known at $t-1$.

The Black CAPM, on the other hand, implies that:

$$\mathrm{E}_{t-1}(z_{jt}) = (1-\beta_{jt})\gamma_{0t} + \beta_{jt}\mathrm{E}_{t-1}(z_{mt}), \qquad (3)$$

where:

γ_{0t} = the mean return in excess of the risk-free rate on a portfolio that has a zero beta relative to the market portfolio of risky assets – the zero-beta premium.

A regulator using the Black CAPM explicitly would set the cost of equity for a firm equal to:

$$(1-\hat{\beta}_{jt})\hat{\gamma}_{0t} + \hat{\beta}_{jt}\hat{z}_{mt}, \qquad (4)$$

[79] 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.

[80] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 496.

where a hat denotes a forecast generated from data prior to month t. The expression (4), however, can also be rewritten as:

$$\beta_{jt}^{*}\hat{z}_{mt}, \tag{5}$$

where

$$\beta_{jt}^{*} = \left(1 - \frac{\hat{\gamma}_{0t}}{\hat{z}_{mt}}\right)\hat{\beta}_{jt} + \left(\frac{\hat{\gamma}_{0t}}{\hat{z}_{mt}}\right) \tag{6}$$

Thus if a regulator were to use (5) to set the cost of equity for a firm, it would come up with exactly the same result as if it were to use (4). In other words, the regulator could use the SL CAPM together with an adjusted estimate of the equity beta of a firm to compute an estimate of the cost of equity instead of using the Black CAPM and an unadjusted estimate of the equity beta of the firm. The adjusted estimate of beta is, from (6), a weighted average of the unadjusted estimate of beta and one.

NERA assumes in its February 2015 report that the AER acts as if it adjusts an estimate of the equity beta of an NSP solely on the basis of the principles underpinning the Black CAPM.[81] NERA does so because to evaluate a method for estimating the return required on equity, it must clearly specify the method. Methods that it cannot clearly specify, it cannot evaluate. NERA cannot, for example, evaluate the use by a regulator of its discretion in a way that is not specified and in a way that may vary through time.

To be able to evaluate forecasts of the cost of equity that a regulator would have generated using this scheme, one must know what weight the regulator places on an unadjusted estimate of beta.

In its draft decisions, the AER states that:[82]

> 'We adopt an equity beta point estimate of 0.7 from a range of 0.4 to 0.7.'

Thus it is reasonable to assume that the AER adjusts upwards an estimate of 0.55 – the midpoint of the range of 0.4 to 0.7 – to 0.7. Simple arithmetic indicates that the AER places a weight of two thirds on an unadjusted estimate of beta and one third on one in deriving its adjusted point estimate of beta. That is:

$$\frac{2}{3} \times 0.55 + \frac{1}{3} \times 1 = 0.7 \tag{7}$$

From (6), the use of a weight of two thirds on an unadjusted estimate of beta implies that the AER currently acts as if it believes that the zero-beta premium should be one third of the value of the *MRP*. That is:

$$\left(1 - \frac{\hat{\gamma}_{0t}}{\hat{z}_{mt}}\right) = \frac{2}{3} \Rightarrow \hat{\gamma}_{0t} = \frac{1}{3}\hat{z}_{mt} \tag{8}$$

Since the AER chooses a value for the *MRP* of 6.5 per cent per annum, then, with the assumptions made, the AER currently acts as if it believes that the zero-beta premium is 2.17 per cent per annum.

[81] 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.

[82] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 126.

We should emphasise that while the AER acts as though it believes that the zero-beta premium is 2.17 per cent per annum, it does not state that it believes the zero-beta premium should take on this value. The AER states instead that:[83]

> 'Our assessment of the merits and limitations of the Black CAPM leads us to give it an informative, not determinative, role in estimating the equity beta for the benchmark efficient entity.'
>
> 'we use judgement to consider the evidence is not inconsistent with an equity beta towards the upper end of the range.'

Thus the AER does not link its adjustment in any quantitative way to the evidence against the SL CAPM. The AER instead chooses an adjustment that is linked to the range of unadjusted estimates for the equity beta of an NSP that the AER considers. This range will reflect not the evidence that exists against the SL CAPM but the uncertainty that the AER has about what an appropriate unadjusted value for the equity beta of an NSP should be. A wide range will reflect a great deal of uncertainty on the part of the AER about what an appropriate unadjusted value for the equity beta of an NSP should be. A narrow range will reflect little uncertainty on the part of the AER about what an appropriate unadjusted value for the equity beta of an NSP should be. Again, though, how certain the AER is about what the unadjusted equity beta of an NSP should be will not provide a measure of how badly estimates of the cost of equity produced by the SL CAPM will mislead.

Figure 1 below shows that using the Black CAPM and an estimate of the zero-beta premium that places a weight of two thirds on zero and a weight of one third on the *MRP* will deliver the same cost of equity as using the SL CAPM and an adjusted estimate of beta that places a weight of two thirds on an unadjusted estimate and a weight of one third on one. The figure uses numbers from the AER's draft decisions. The midpoint of the AER's range for beta is 0.55 but it chooses to use an estimate instead of 0.70 – which could have been arrived at by multiplying 0.55 by two thirds and adding one third to the result. The use of the SL CAPM, a beta of 0.70 and an *MRP* of 6.50 per cent per annum will deliver a mean excess return to equity of 4.55 per cent per annum. This mean excess return could also have been produced using the Black CAPM, a beta of 0.55 and a zero-beta premium that places a weight of two thirds on zero and a weight of one third on the *MRP* of 6.50 per cent per annum – that is, a zero-beta premium of 2.17 per cent per annum.

We label forecasts, generated using the SL CAPM and an estimate of beta that is one third plus two thirds of an unadjusted estimate, forecasts generated by the AER CAPM. We examine forecasts generated by the AER CAPM and also forecasts generated by an empirical version of the Black CAPM. Our empirical version of the Black CAPM uses the scheme outlined above to compute an adjusted estimate of beta for use with the SL CAPM – but relies on past data to estimate the zero-beta premium instead of the implicit assumption adopted by the AER that the premium is 2.17 per cent per annum.

Like NERA in its February 2015 report, we use past data to compute recursive estimates of the monthly zero-beta premium and recursive estimates of the *MRP*.[84] The recursive estimates of the zero-beta premium 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).[85] For each month *t* we compute a forecast for the month of the zero-beta premium as the average of all monthly zero-beta premium estimates up until month *t* – 1.

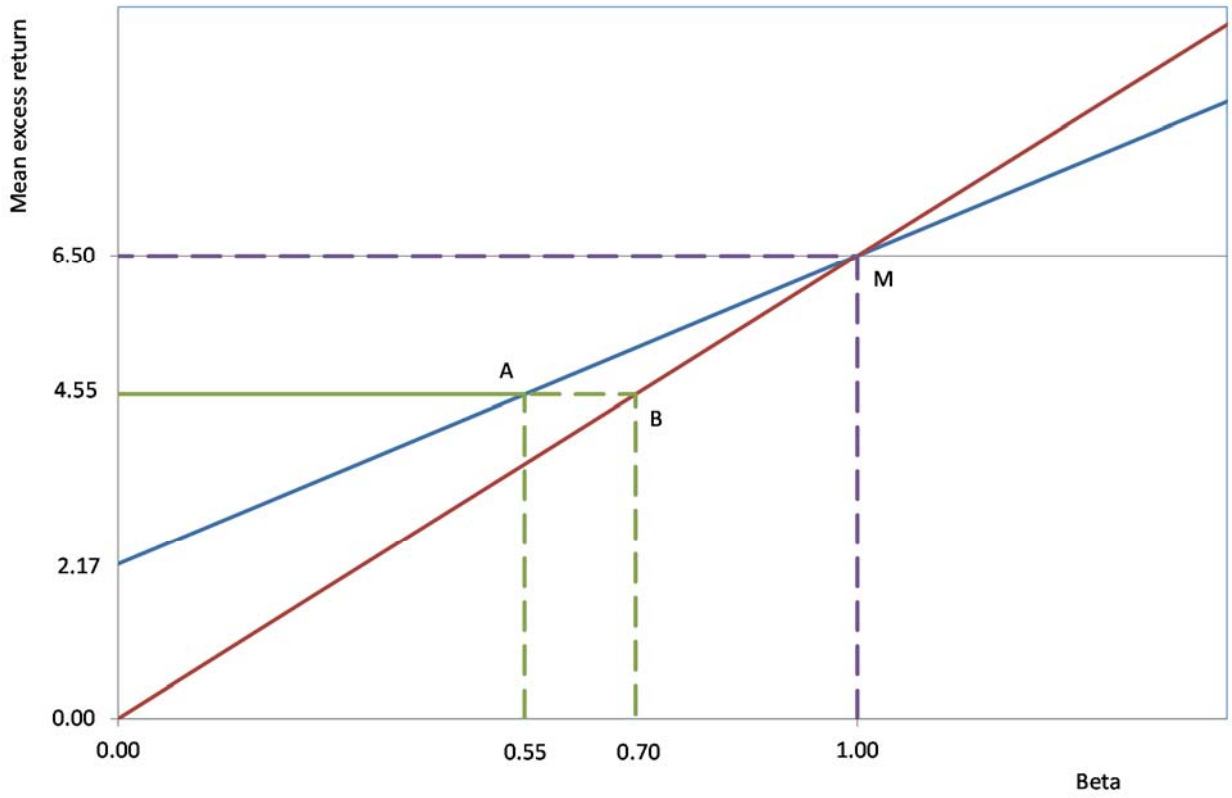
[83] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 499.

[84] 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.

[85] 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.

Figure 1: The AER's Implementation of the SL CAPM



Note: The SL CAPM is represented by the red line while the Black CAPM is represented by the blue line. The two lines cross at the point where beta is one.

2.3 Empirical Evidence

2.3.1 Method

If the regulator's assessment of the *MRP* is rational, that is, unbiased, then:

$$E(\hat{z}_{mt}) = E(z_{mt}) \quad (9)$$

In words, if the regulator's assessment of the *MRP* is rational, the assessment will on average match the true *MRP*. The idea that the regulator's assessment is rational does not presume that the AER uses an historical average of past excess returns to the market portfolio to predict the *MRP*. The idea merely presumes that the AER does not persistently underestimate or overestimate the *MRP*.

If forecasts generated by the SL CAPM are unbiased and the regulator's assessment of the *MRP* is rational, then:

$$E(z_{jt} - \hat{\beta}_{jt} z_{mt}) = 0 \quad (10)$$

We test whether the restriction (10) holds true by examining whether its sample counterpart:

$$\frac{1}{T}\sum_{t=1}^{T}(z_{jt} - \hat{\beta}_{jt} z_{mt}) \quad (11)$$

differs significantly from zero, where T denotes the number of monthly observations.[86] Thus our tests use realisations of the excess return to the market portfolio and not forecasts. We use realisations because, again, we assume that the AER's assessments of the *MRP* are rational. The quantity (10) is the mean difference between two zero-investment strategies:

- the quantity z_{jt} is the return to a zero-investment strategy that is long portfolio j and short the risk-free asset.
- the quantity $\hat{\beta}_{jt} z_{mt}$ is the return to a zero-investment strategy that is long the market portfolio and short the risk-free asset.

If the SL CAPM generates forecasts that are unbiased and the regulator's assessment of the *MRP* is rational, then the mean difference between the returns to the two zero-investment strategies should be zero.

We test the AER CAPM and the Black CAPM in the same way. Thus we test whether forecasts generated by the AER CAPM and the Black CAPM are unbiased by examining whether the mean forecast error:

$$\frac{1}{T}\sum_{t=1}^{T}(z_{jt} - \beta^{*}_{jt} z_{mt}) \quad (12)$$

differs significantly from zero.

2.3.2 Data

We use monthly data from January 1969 to December 2013 from SIRCA's Share Price and Price Relative (SPPR) database to evaluate the empirical performance of the four pricing models.[87] Thus our tests use the data that NERA employs in its February 2015 report updated to December 2014.[88] These data are the longest reliable series of returns on a large cross-section of Australian stocks that are available. The SPPR database uses data provided by the Australian Securities Exchange (ASX).

Like Black, Jensen and Scholes (1972), Fama and MacBeth (1973), Campbell and Vuolteenaho (2004) and Lewellen, Nagel and Shanken (2010), we test pricing models using the returns to portfolios of stocks.[89] The model that the AER chooses as its 'foundation' model is the SL CAPM and this model implies, like the Black CAPM, that variation across equities in their mean returns will be completely explained by variation in their betas. So a sensible way of constructing portfolios to be used in evaluating the empirical performance of the four models is to form portfolios, like Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), on the basis of past estimates of beta.[90]

[86] Thus the tests that we use in this report employ what NERA in its February 2015 report labels Method B.

[87] SIRCA Australian Share Price and Price Relative (SPPR) information supplied by RoZetta Technology Pty Ltd (www.rozettatechnology.com).

[88] 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.

[89] Black, F, M. Jensen and M. Scholes, *The Capital Asset Pricing Model: Some empirical tests, in Studies in the Theory of Capital Markets*, ed. M. Jensen, Praeger, New York, 1972.

Campbell, J. and T. Vuolteenaho, *Bad beta, good beta*, American Economic Review, 2004, page 1249.

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

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

[90] Black, F, M. Jensen and M. Scholes, *The Capital Asset Pricing Model: Some empirical tests, in Studies in the Theory of Capital Markets*, ed. M. Jensen, Praeger, New York, 1972.

To form portfolios on the basis of past estimates of beta, we begin by extracting data from January 1969 to December 2014 for individual stocks from the SPPR database.[91] The SPPR database does not provide market capitalisations before December 1973 and so we do not begin to record the returns to the portfolios that we construct until January 1974. We use past estimates of betas to allocate stocks to portfolios, however, and so we use data from before January 1974 to determine in which portfolios to place stocks in the early years of the time series that we construct. To minimise the impact of market microstructure effects, at the end of each year we use past data to estimate the betas only of stocks that are in the top 500 by market capitalisation. We choose the top 500 because the All Ordinaries Index is constructed from the top 500 stocks and the AER uses this index in computing an estimate of the *MRP*.

We form value-weighted portfolios on the basis of past beta estimates in the following way. At the end of December each year we use data for the prior five years to estimate the betas of all stocks relative to the market portfolio, dropping those that do not have a full 60 months of data. We then place the stocks into 10 portfolios on the basis of the estimates and record the returns to these portfolios for each month of the following year. So, for example, we compute beta estimates using data from January 1969 to December 1973 for stocks that are in the top 500 by market capitalisation at the end of December 1973. We allocate these stocks to 10 portfolios on the basis of these estimates and then record the returns to the portfolios for each month of 1974. Next, we compute beta estimates using data from January 1970 to December 1974 for stocks that are in the top 500 by market capitalisation at the end of December 1974, allocate these stocks to 10 portfolios on the basis of the estimates and then record the returns to the portfolios for each month of 1975. And so on. We also form a value-weighted portfolio of the top 500 stocks by market capitalisation and use the portfolio as a proxy for the market portfolio.

We compute the returns to the portfolios that we use inclusive of a value assigned to imputation credits. In particular, we assign a value of 35 cents to each dollar of imputation credits distributed. Thus the partially franked returns that we use are the unfranked returns plus 35 percent of the difference between the fully franked and unfranked returns.

We use as a measure of the risk-free rate the yield, computed on a monthly basis, on a 10-year Commonwealth Government Security. We do so because the AER uses the 10-year yield as its measure of the risk-free rate.[92] We extract the end-of-month yields on these bonds from the Reserve Bank of Australia.

2.3.3 Results

Like Fama and French (1997), we assess forecasts constructed using both rolling estimates of beta and recursive estimates of beta.[93] The rolling estimates of beta that we use each month employ data over the previous 60 months to compute a forecast of beta. The recursive estimates that we use each month employ all previously available data – and never less than 60 months of data – to compute a forecast of beta.

Table 1 provides the results of out-of-sample tests of the naïve model, SL CAPM, AER CAPM and Black CAPM that use the 10 portfolios and rolling estimates of beta.[94] Table 2 provides the results of out-of-sample tests of these models that use the 10 portfolios and recursive estimates of beta. Rolling estimates of beta are more likely to pick up variation in the betas of the 10 portfolios through time while recursive estimates use more data and so are likely to be more precise.

Table 1 and Table 2 show that Wald tests of the restrictions that the SL CAPM and AER CAPM impose can be rejected at the five per cent level regardless of whether rolling or recursive estimates of beta are

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

[91] We exclude the very small number of price relatives that are negative. On the other hand, we do not exclude those stocks that are in the SPPR database that are headquartered abroad. Like NERA, we find that the results are not sensitive to the exclusion of stocks headquartered abroad.

[92] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 89.

[93] Fama, E. F. and K. R. French, *Industry costs of equity*, Journal of Financial Economics, 1997, pages 153-193.

[94] We compute the returns to portfolios formed on the basis of past estimates of beta from January 1974 to December 2014 and we use 60 months of returns to compute a forecast of beta. Thus the first forecast that we evaluate is for January 1979.

employed. The tables show, on the other hand, that Wald tests cannot reject either the naïve model or the Black CAPM. The Wald statistics that we report for each pricing model are for tests of the hypothesis that the model delivers forecasts of the return to the 10 portfolios that are all unbiased. Importantly, the statistics take into account the dependence that exists across the returns to the 10 portfolios.

Forecasts that the naïve model and the Black CAPM produce are similar because at each point in time the Black model looks back at past data, sees little relation between mean return and beta and so sets the betas of the 10 portfolios close to one. Following this strategy provides forecasts of the cost of equity that are similar to the forecasts generated by a naïve model. Wald tests cannot reject the hypothesis that both models generate forecasts that are unbiased.

Portfolios 1 through 4 – all low-beta portfolios – are significantly mispriced by the SL CAPM and AER CAPM. Both models significantly underestimate the returns required on these four portfolios. The two models also significantly overestimate the return required on portfolio 9 – a high-beta portfolio. The return to portfolio 4 is sufficiently high that even the naïve model and Black CAPM significantly underestimate its return. Figure 2 below shows graphically how poorly the SL CAPM performs and so the challenge that the AER faces in constructing adjustments that will render estimates of the return required on an NSP that use the model unbiased – or at least not significantly biased. The figure plots the average returns to the 10 portfolios formed on the basis of past estimates of beta against the averages of the rolling estimates that appear in Table 1. The figure shows that over the period 1979 through 2014 there has been a negative rather than a positive relation in Australia between average returns and estimates of their betas.

While Tables 1 and 2 show that there is strong evidence that the SL CAPM and the AER CAPM does not work for low-beta and high-beta portfolios, the tables do show that there is little evidence against the models in these tests for portfolios whose betas lie close to one. Of course, for these portfolios, the predictions made by the naïve model, the SL CAPM, the AER CAPM and the Black model are very similar. It is only for portfolios that have low or high betas that the predictions of the models differ significantly from one another.

2.3.4 Sensitivity

We assume that the AER adjusts upwards an estimate of the equity beta of an NSP of 0.55 – the midpoint of the range that the AER employs of 0.4 to 0.7 – to 0.7. The AER, however, refers to an estimate of 0.50 as its best estimate while in a recent decision the ERA provides an estimate of the equity beta of an NSP of around 0.60.[95] We examine the sensitivity of our results to changes in the assumption that we make about how the AER computes an adjusted estimate of the equity beta of an NSP.

Simple arithmetic indicates that if the AER were to adjust upwards an estimate of 0.50 to 0.70, then the AER would effectively place a weight of three fifths on an unadjusted estimate of beta and a weight of two fifths on one in deriving its adjusted point estimate of beta. That is:

$$\frac{3}{5} \times 0.50 + \frac{2}{5} \times 1 = 0.7 \qquad (13)$$

[95] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 481.

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 192.

Table 1: Out-of-Sample Tests of a Naïve model, the SL CAPM, the AER CAPM and the Black CAPM, Rolling Estimates of Beta and Portfolios Formed on the Basis of Past Estimates of Beta

		Mean forecast error			
Portfolio	β	Naïve model	Sharpe-Lintner CAPM	AER CAPM	Black CAPM
1	0.55	3.24	**6.29**	**5.27**	3.05
		(2.17)	(1.86)	(1.88)	(2.27)
2	0.58	3.35	**5.92**	**5.05**	3.01
		(2.03)	(1.80)	(1.81)	(2.05)
3	0.68	2.64	**4.44**	**3.84**	2.60
		(1.90)	(1.74)	(1.73)	(1.88)
4	0.78	**4.04**	**5.27**	**4.86**	**3.90**
		(1.75)	(1.67)	(1.66)	(1.74)
5	0.96	2.53	2.40	2.45	2.68
		(1.70)	(1.68)	(1.67)	(1.70)
6	0.99	1.26	1.25	1.25	1.39
		(1.48)	(1.46)	(1.45)	(1.45)
7	1.11	-0.91	-1.80	-1.51	-0.65
		(1.66)	(1.63)	(1.62)	(1.67)
8	1.24	-0.40	-1.85	-1.36	-0.23
		(1.93)	(1.85)	(1.85)	(1.97)
9	1.33	-3.36	**-5.05**	**-4.49**	-3.24
		(2.39)	(2.23)	(2.24)	(2.41)
10	1.38	-2.90	-4.84	-4.19	-2.77
		(3.77)	(3.66)	(3.66)	(3.78)
Wald		9.49	**32.55**	**23.88**	9.17
		[0.49]	[0.00]	[0.01]	[0.52]

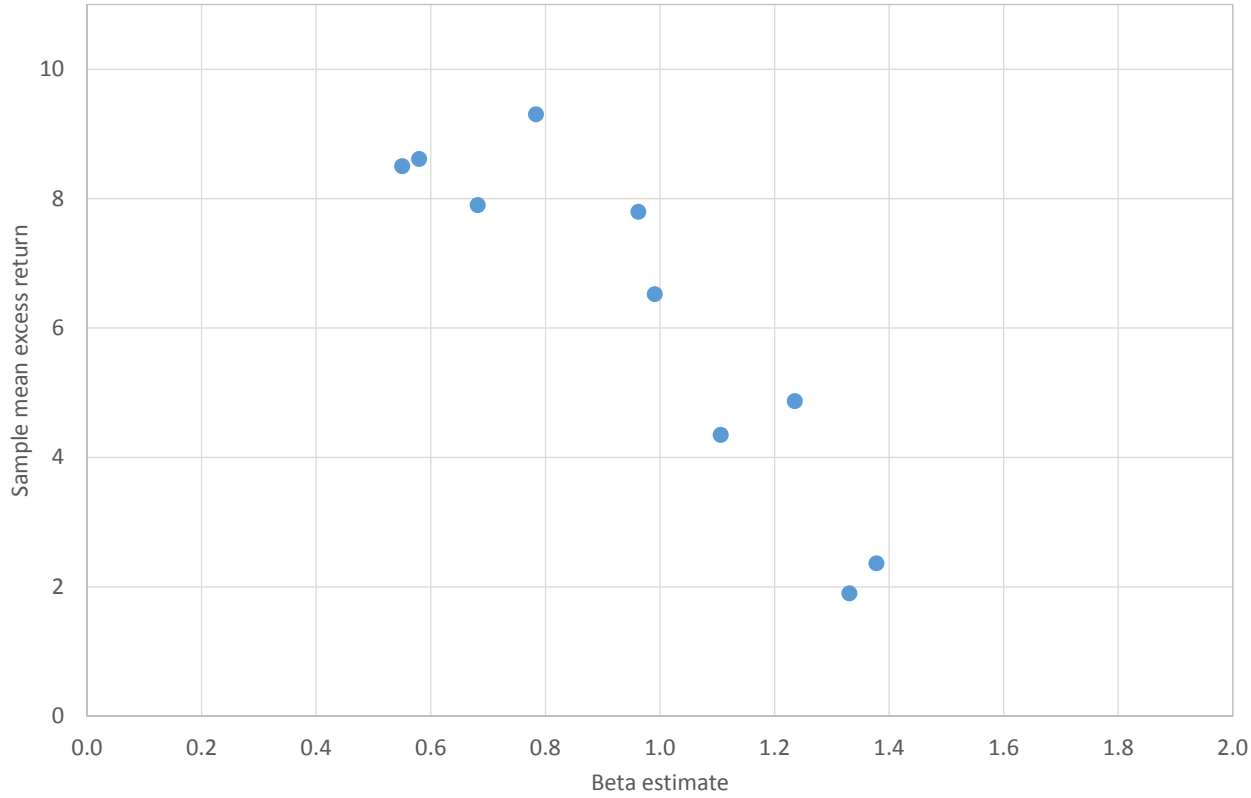
Notes: The results are for the period January 1979 to December 2014. Sample mean forecast errors in per cent per annum are outside of parentheses while the standard errors of the means are in parentheses. Estimates of β are the averages of the rolling estimates. Wald statistics for tests of each model are outside of brackets while the p-values associated with the statistics are in brackets. Mean forecast errors that differ significantly from zero at the five per cent level are in bold. Wald statistics that lead to a rejection of a model at the five per cent level are also in bold.

Table 2: Out-of-Sample Tests of a Naïve model, the SL CAPM, the AER CAPM and the Black CAPM, Recursive Estimates of Beta and Portfolios Formed on the Basis of Past Estimates of Beta

		Mean forecast error			
Portfolio	β	Naïve model	Sharpe-Lintner CAPM	AER CAPM	Black CAPM
1	0.50	3.24	**5.99**	**5.08**	3.05
		(2.17)	(1.84)	(1.86)	(2.27)
2	0.62	3.35	**5.34**	**4.68**	3.17
		(2.03)	(1.80)	(1.81)	(2.05)
3	0.58	2.64	**4.92**	**4.16**	2.48
		(1.90)	(1.74)	(1.70)	(1.90)
4	0.77	**4.04**	**5.17**	**4.79**	**3.89**
		(1.75)	(1.67)	(1.67)	(1.75)
5	0.85	2.53	3.23	3.00	2.45
		(1.70)	(1.70)	(1.69)	(1.70)
6	0.88	1.26	1.90	1.68	1.24
		(1.48)	(1.49)	(1.46)	(1.45)
7	0.97	-0.91	-0.83	-0.86	-0.92
		(1.66)	(1.67)	(1.66)	(1.66)
8	1.18	-0.40	-1.36	-1.03	-0.28
		(1.93)	(1.84)	(1.85)	(1.96)
9	1.36	-3.36	**-5.22**	**-4.60**	-3.17
		(2.39)	(2.22)	(2.23)	(2.42)
10	1.39	-2.90	-4.94	-4.26	-2.68
		(3.77)	(3.62)	(3.64)	(3.79)
Wald		9.49	**30.95**	**23.87**	8.71
		[0.49]	[0.00]	[0.01]	[0.56]

Notes: The results are for the period January 1979 to December 2014. Sample mean forecast errors in per cent per annum are outside of parentheses while the standard errors of the means are in parentheses. Estimates of β are the averages of the recursive estimates. Wald statistics for tests of each model are outside of brackets while the p-values associated with the statistics are in brackets. Mean forecast errors that differ significantly from zero at the five per cent level are in bold. Wald statistics that lead to a rejection of a model at the five per cent level are also in bold.

Figure 2: Sample Mean Excess Return against Beta Estimate for Portfolios Formed on the Basis of Past Estimates of Beta



Note: The results are for the period January 1979 to December 2014. The beta estimates are averages of the rolling estimates.

We find that the Wald statistic (p-value) for a test of a model that uses the SL CAPM and estimates of beta adjusted in this way is 21.96 (0.02) using rolling estimates of beta and 22.09 (0.01) using recursive estimates.

If the AER were to adjust upwards an estimate of 0.60 to 0.70, then the AER would effectively place a weight of three quarters on an unadjusted estimate of beta and a weight of one quarter on one in deriving its adjusted point estimate of beta. That is:

$$\frac{3}{4} \times 0.60 + \frac{1}{4} \times 1 = 0.7 \qquad (14)$$

We find that the Wald statistic (p-value) for a test of a model that uses the SL CAPM and estimates of beta adjusted in this way is 26.29 (0.00) using rolling estimates of beta and 26.03 (0.00) using recursive estimates.

Thus we find that our results are not sensitive to these small changes in the assumption that we make about how the AER adjusts an estimate of the equity beta of an NSP.

We also examine the sensitivity of our results to changes in the assumption that we make about theta, the market value of a one-dollar imputation credit distributed. The AER uses a value for theta of around 0.60.[96]

[96] A value for theta of 0.60 lies within the range of values for theta that the AER employs. See:

We find that the Wald statistic (p-value) for a test of the AER CAPM that employs this assumption for theta is 24.81 (0.01) using rolling estimates of beta and 24.68 (0.01) using recursive estimates.

Thus we also find that our results are not sensitive to changes in the assumption that we make about the value that the market places on a one-dollar credit distributed.

2.4 Discussion

2.4.1 Relation of the results to existing work

The evidence that we provide is consistent with evidence that others provide.

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.[97] 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 we do, 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 we report here and that CEG reporst.

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.[98] 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 (2010) 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.[99] 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.[100] 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.

AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 4: Value of imputation credits*, October 2015, page 18.

[97] 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.

[98] 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.

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

[100] 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.

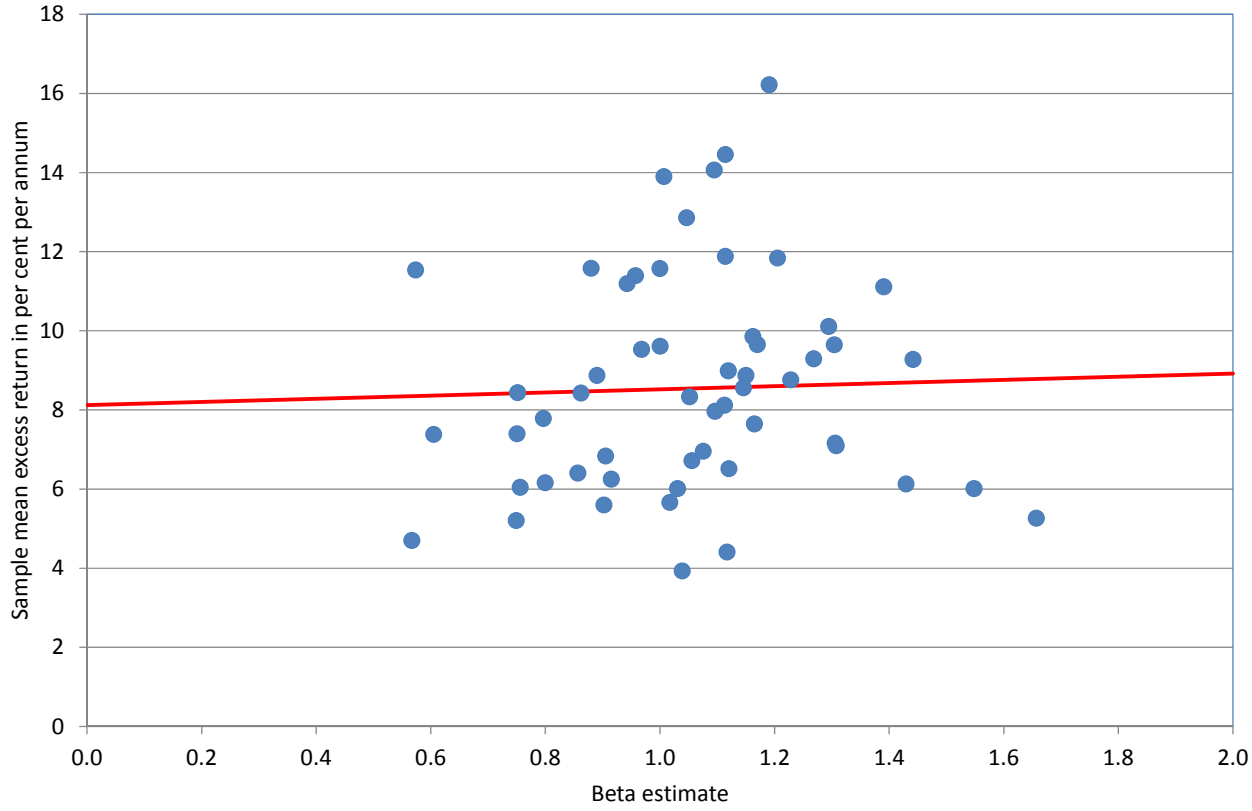
Lewellen, J., S. Nagel and J. Shanken, *A skeptical appraisal of asset pricing tests*, Journal of Financial Economics, 2010, Table 1, page 188.

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.[101] 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.

2.4.2 Implications of the results for the allowed rate of return objective

The evidence provided by Table 1 and Table 2 indicates that the AER's implementation of the SL CAPM will produce downwardly biased estimates of the returns required on low-beta equities and so a downwardly biased estimate of the return required from an NSP. Thus the AER's statement that:[102]

[101] 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.

[102] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 284.

> 'Notwithstanding potential limitations with the model, we consider that our implementation of the model recognises any potential empirical limitations'

is not supported by the evidence. We note again that the AER's implementation of the SL CAPM is not linked in any quantitative way to the evidence against the model. We also note that neither the AER nor its advisers have provided any empirical evidence to contradict the conclusion that the AER's implementation of the SL CAPM will produce downwardly biased estimates of the returns required on low-beta equities and so a downwardly biased estimate of the return required on an NSP. Indeed, Partington and Satchell acknowledge, in referring to the adjustment that the AER makes to the equity beta of an NSP, that:

> 'it is an open question whether this adjustment is too high or too low.'

They argue, however, that:

> '[While w]e sympathise with [the] argument that the AER should present some measure of the quality of its cost of equity estimate and provide a quantitative analysis of the adjustments it makes to the CAPM returns … when a value is chosen from a range of values and the overall process involves both judgement and estimation the exercise becomes very difficult to carry out.'

This argument appears to suggest that so long as the AER can claim to be using judgement – and is not transparent about how it reaches its decisions so that the way in which it uses its judgement cannot be modelled – then its decisions can escape scrutiny and so go unchallenged. Without scrutiny, however, it is difficult to see how one can determine whether the AER's decision on the cost of equity will satisfy the allowed rate of return objective, contained in both the NER (Clause 6.5.2 (c) and Clause 6A.6.2) and NGR (Clause 87 (3)), which states that:

> 'the rate of return … is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk.'

The simplest way of scrutinising a model employed by the AER to estimate the return required on the equity of an NSP is to determine whether the model can produce forecasts of returns that are unbiased. Again, we find that the AER's implementation of the SL CAPM does not produce forecasts of returns that are unbiased.

2.5 Issues Raised by the AER

The AER, in its draft decisions, raises a large number of issues, most of which have been previously addressed by one or more of the consultants to the NSPs.[103] Here we limit our attention to three issues that the AER has raised that relate to the empirical work that we present in this section.

First, we note that the AER states in its draft decisions about the February 2015 report of NERA that:[104]

> '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.'

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

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

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.[105]

The AER's claim that the results that NERA provides in its February 2015 report are counterintuitive can be interpreted in three ways.[106] One interpretation might be that the AER views the results as sufficiently unusual that they throw doubt on the reliability of 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 own adviser, Satchell, in work with Muijsson and Fishwick states that:[107]

> '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 NERA's February 2015 results are unusual relative to the results produced by others.

Another interpretation might be that the AER views the results produced by NERA and others as sufficiently unusual that they can be attributed to bad luck. The significance tests that NERA conducts and that we update and that others conduct, however, are designed to determine whether an outcome can be attributed to chance. The results that we provide here 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 rolling estimates of beta is, from Table 1, 32.55. The p-value associated with this statistic is 0.00032. This means that were the SL CAPM to be true, one would expect to see a Wald statistic as large as 32.55 just 32 times out of every 100,000 independent tests conducted using similar data.

Thus it is very unlikely that the results produced by NERA and others can be attributed to bad luck.

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

The evidence provided by 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 employs – 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 draft decisions about Partington's views that:[108]

> 'Partington previously noted that the foundation model does not provide a downwardly biased estimate in the current context. He also advised:

[105] 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.

[106] 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.

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

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

> 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.[109] 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 draft decisions that:[110]

> 'McKenzie and Partington … stated:
>
> > …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:[111]

- 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.

NERA in a June 2015 report states about the work of Ray, Savin and Tiwari (2009) that:[112]

> '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.'

[109] 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.

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

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

[112] 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.

NERA in a June 2015 report states about the work of Da, Guo and Jagannathan (2012) that:[113]

> '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.''

2.6 Issues Raised by the AER's Advisers

2.6.1 Black CAPM

Partington and Satchell state about estimates of the zero-beta premium that:[114]

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

In our empirical work, we use 622 monthly estimates of the zero-beta premium from March 1963 to November 2014. 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. [115] 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.[116] The point that Partington and Satchell make is that there is a chance –

[113] 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.

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

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

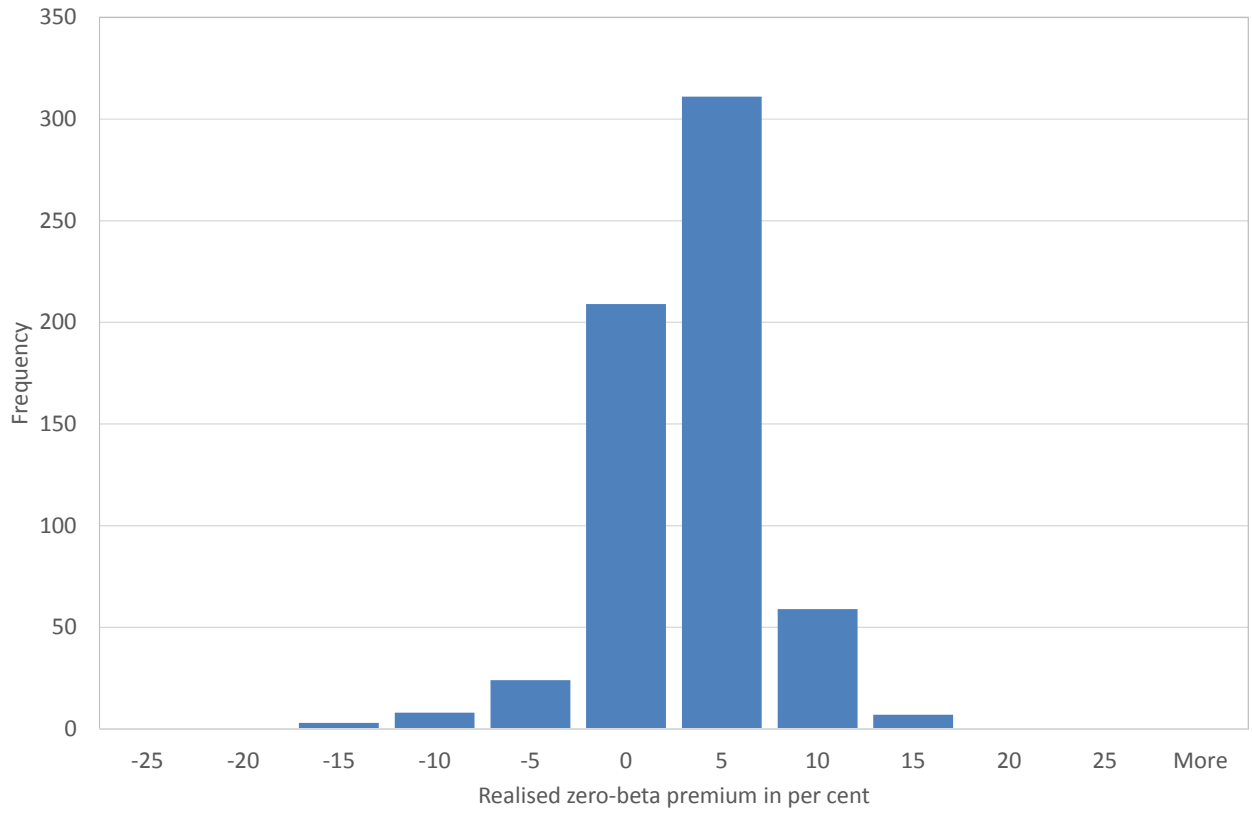
Fama, Eugene F. and James D. Macbeth, *Risk, return and equilibrium: Empirical tests*, Journal of Political Economy, 1973, pages 607-636.

[116] 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.

albeit very, very small – that one of these realised excess returns 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 in Figure 4 a histogram that summarises the behaviour of the data. The figure shows that none of the estimates are 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 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).

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. As we have already made clear, 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. Again, the evidence that we provide 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. This suggests that the argument that Partington and Satchell make that estimates of the zero-beta rate are 'virtually worthless' is incorrect.

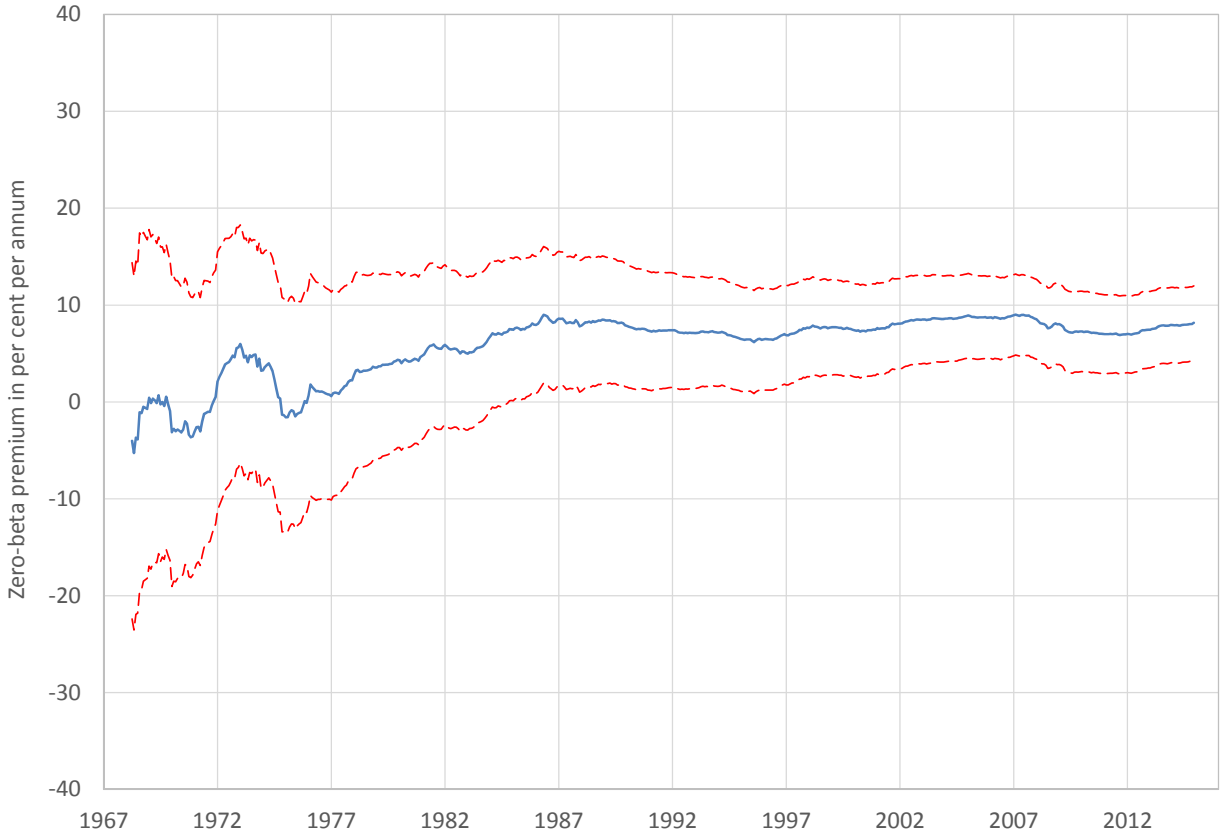
Partington and Satchell also claim in their October 2015 report that:[117]

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

> '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 both NERA and SFG suggest that an estimate of the zero-beta rate be 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 we provide 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 SL CAPM or AER 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.[118] Partington and Satchell raise further issues. Partington and Satchell state in their October 2015 report that:

[118] 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.

> '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 β i→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 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.[119]

In addition, as NERA notes in its June 2013 report:[120]

> '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, like NERA and SFG, 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.

2.6.2 Fama-French three-factor model

Partington and Satchell state in their October 2015 report about the Fama-French three-factor model that:[121]

> 'With the original Fama and French model under revision by its originators, this does not seem to be an appropriate time for the AER to adopt the FF model.'

[119] 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.

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

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

We note that Fama and French in recent work that examines the performance of a five-factor model do not suggest that they now consider their three-factor model to provide estimates of the returns required on equities that are inferior to those produced by the SL CAPM.[122] They argue instead that a five-factor model may provide estimates of the returns required on equities that are superior to those produced by their three-factor model.

We note, in addition, that the argument that Partington and Satchell make in their October 2015 report could also be used to suggest that it 'does not seem to be an appropriate time for the AER to adopt' the SL CAPM over 40 years after the SL CAPM was revised to take into account defects associated with the model.

Partington and Satchell state in their October 2015 report about the work of Kan, Robotti and Shanken (2013) that:[123]

> '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.'

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.[124] 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. Again, Satchell in work with Muijsson and Fishwick states that:[125]

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[122] Fama, E.F. and K.R. French, *International tests of a five-factor asset pricing model*, University of Chicago, IL, June 2015.

[123] 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.

[124] 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.

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

> '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:[126]

> '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.[127]

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

[127]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. Long-Run *MRP*

The AER in its October 2015 decision and Partington and Satchell in their October 2015 report raise a number of issues about NERA's June 2015 *MRP* report and we address these issues here.[128]

3.1 Historical Data

In its June 2015 report, NERA provides estimates of the long-run *MRP* that use annual data from 1883 through 2014.[129] It finds that an estimate of the *MRP* is 6.55 per cent per annum and that the standard error attached to the estimate is 1.44 per cent per annum. This estimate uses an assumption that the market places a value of 35 cents on a dollar of imputation credits distributed.[130, 131]

NERA's data, like the data that the AER uses, employs a series of yields that Lamberton (1961) provides.[132] Brailsford, Handley and Maheswaran (2008) suggest that the series that Lamberton provides overstates the yield on the Commercial and Industrial/All Ordinaries price series that Lamberton (1958) also supplies.[133] Lamberton's yields, provided for the Sydney Stock Exchange (SSE), are equally weighted, use only stocks that pay dividends and use more stocks than do the price indices – which were also constructed by Lamberton for the SSE. The evidence that NERA provides in its June 2015 report suggests that some adjustment should be made to Lamberton's yield data but that the adjustment should be smaller than the adjustment that Brailsford, Handley and Maheswaran believe to be appropriate.[134] NERA reaches this conclusion by examining the original sources that Lamberton uses for the quarters ending in December

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

NERA, *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.

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

[129] NERA, *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.

[130] NERA, like Brailsford, Handley and Maheswaran (2008, 2012), uses imputation credit yields for December of each year taken from the Australian Taxation Office (ATO). At the time that NERA's June *MRP* report was written the ATO had yet to update its data beyond September 2014 and so NERA used the credit yield of 1.43 per cent per annum that the ATO reported for September 2014 in place of a December 2014 yield. The ATO has now provided a credit yield for December 2014 and it too is 1.43 per cent per annum and so we have not revised NERA's estimates in any way.

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

Brailsford, T., J. Handley and K. Maheswaran, *The historical equity risk premium in Australia: Post-GFC and 128 years of data*, Accounting and Finance, 2012, pages 237-247.

[131] This value is the value laid down by the ACT in a decision on the market value of a one-dollar credit distributed. See

ACT, Application by Energex Limited (Gamma) (No 5) [2011] ACompT9, May 2011.

A value of 60 cents, on the other hand, lies within the range of values that the AER employs. If a value of 60 cents were used, then an estimate of the *MRP* would be 6.64 per cent per annum. See:

AER, *Preliminary decision Jemena distribution determination 2016–20: Attachment 4: Value of imputation credits*, October 2015, page 18.

[132] Lamberton, D., *Ordinary share yields: A new statistical series*, Sydney Stock Exchange Official Gazette, 14 July 1961.

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

Lamberton, D., *Security prices and yields*, Sydney Stock Exchange Official Gazette, 14 July 1958.

Lamberton, D., *Share price indices in Australia*, Sydney: Law Book Company, 1958.

Lamberton, D., *Some statistics of security prices and yields in the Sydney market, 1875-1955*, Economic Record, 1958, pages 253-259.

[134] NERA, *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.

1883, December 1891, December 1901, December 1911, December 1921, December 1931, December 1941, and December 1951 and by using Brailsford, Handley and Maheswaran's analysis of yield data for February 1966. The use of NERA's adjustment in place of the adjustment that Brailsford, Handley and Maheswaran employ adds 37 basis points to an estimate of the *MRP* computed using annual data from 1883 to 2014.

In its draft decisions, the AER makes four points and we address each in turn. First, the AER states that:[135]

> 'it was the ASX (at that time, the SSE) that made the adjustment to the earlier data, and it is the ASX's adjustment that NERA is disputing.'

The AER then goes to quote from an article authored by Fitzherbert (2006) that states that:[136]

> 'the ASX Statistician (1996) compiled a quarterly accumulation index dating back to 1882 which corresponds with the ASX All Ordinaries accumulation index, which has been calculated daily since 1979.'

We note that the SSE ceased to exist as a separate entity in 1987 and so the AER's statement contradicts the statement that Fitzherbert makes. We also note that the ASX Statistician to which Fitzherbert refers is a person and not a publication. We thank Fitzherbert for making this clear to us. We are not aware of any ASX or SSE publication that uses the adjustment that the AER and Brailsford, Handley and Maheswaran employ and the AER has not provided a reference to one. We note further that the ASX has made clear in writing that it holds no view as to whether or how Lamberton's series of yields should be adjusted and we believe, quite reasonably, that the most reliable source for what view the ASX holds on the matter is the ASX itself.[137]

Second, the AER asserts that the evidence that Fitzherbert (2006) provides supports the use of the adjustment that Brailsford, Handley and Maheswaran (2008) employ.[138] Fitzherbert states that:[139]

> 'Over the period 1955–1979 (excluding 1961–1965), there was an average difference of 2.3% between the market-weighted average dividend yield of the stocks in the Melbourne 50 Leaders index and the unweighted average of all stocks calculated by the Sydney exchange.'
>
> 'A comparison of columns (2) and (3) – the total return of the ASX accumulation index compared to an estimate based on unweighted dividend yields – shows an average (and reasonably consistent) difference in total return of just under 2% per annum. On the basis of the limited comparison between the weighted dividend data from the Melbourne Stock Exchange and the unweighted Sydney data, this suggests that the dividend factor built into the recently compiled ASX accumulation index is more or less correct.'

Figure 6 plots the adjustment factors that NERA produces against time and it is clear from this figure that a reliance on an adjustment factor that uses only data from 1955 onwards is likely to mislead. Thus the evidence does not support the AER's assertion.[140] Fitzherbert does not use data from before 1955 to assess what adjustment to Lamberton's yield data would make sense.

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[135] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 380.

[136] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, page 20.

[137] https://www.aer.gov.au/system/files/United%20Energy%20-%20Submission%20on%20JGN%20draft%20decision%20-%20ASX%20letter%20to%20UED%20-%2027%20March%202015.pdf

[138] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

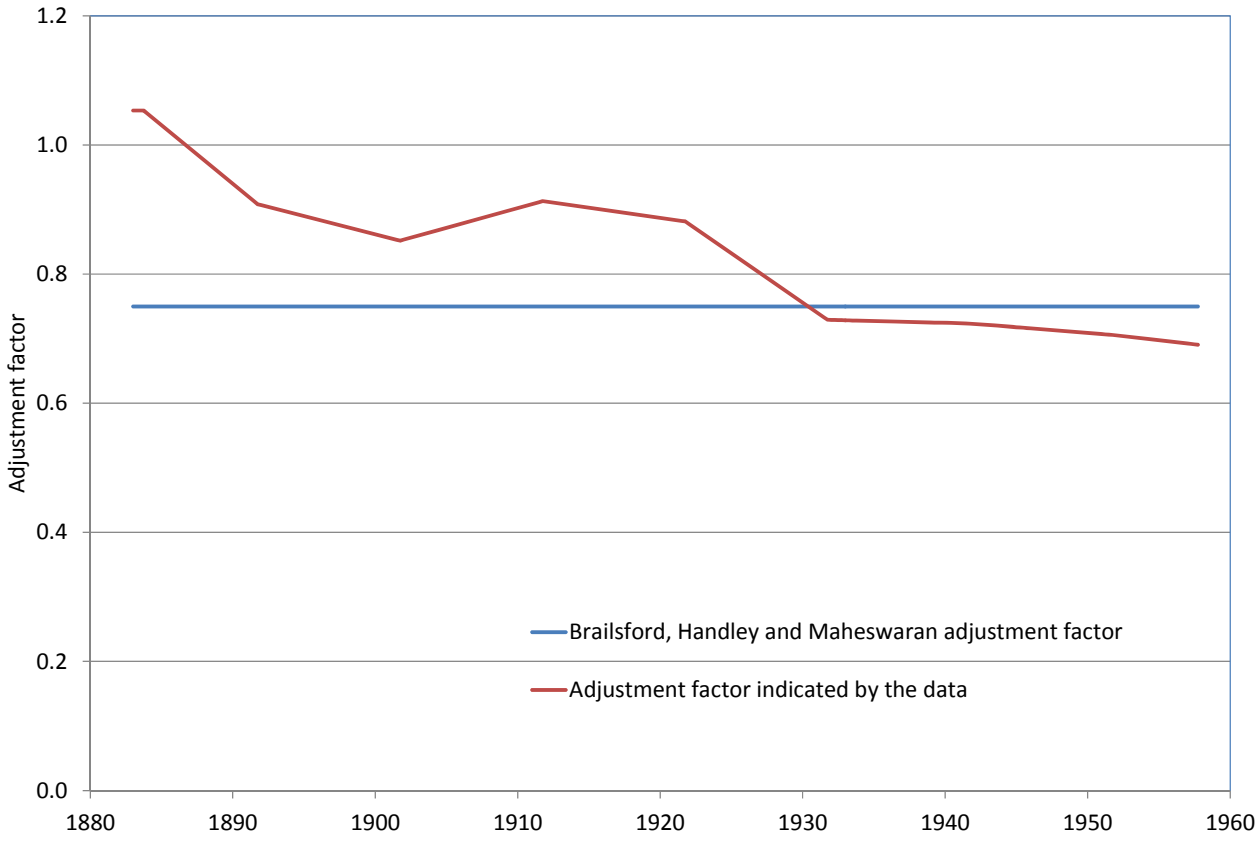
Brailsford, T., J. Handley and K. Maheswaran, *Re-examination of the historical equity risk premium in Australia*, Accounting and Finance 48, 2008, pages 73-97.

Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, pages 20-25.

[139] Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, page 23.

[140] Note that the 'comparison of columns (2) and (3)' to which Fitzherbert refers is a comparison of the adjusted and unadjusted returns with which Fitzherbert had been supplied.

Figure 6: Adjustment Factors



Source: NERA, June 2015.

Third, the AER states that:[141]

> 'it is not reasonable to draw a conclusion about the adjustment factor for 300 data points from a sample of eight of those data points.'

We note that NERA (2013, 2015) examines the original sources that Lamberton (1958) uses for the quarters ending in December 1883, December 1891, December 1901, December 1911, December 1921, December 1931, December 1941, and December 1951 and, in addition, uses Brailsford, Handley and Maheswaran's (2008) analysis of yield data for February 1966.[142] So NERA uses nine and not eight data points. Regardless, however, it is difficult to see that the analysis by Brailsford, Handley and Maheswaran of a single month in 1966 or Fitzherbert's (2006) analysis of data from 1955 to 1979 will provide a more reliable

[141] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 382.

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

Lamberton, D., *Security prices and yields*, Sydney Stock Exchange Official Gazette, 14 July 1958.

Lamberton, D., *Share price indices in Australia*, Sydney: Law Book Company, 1958.

Lamberton, D., *Some statistics of security prices and yields in the Sydney market, 1875-1955*, Economic Record, 1958, pages 253-259.

NERA, *The market, size and value premiums: A report for the ENA*, June 2013.

NERA, *The market risk premium: Analysis in response to the AER's Draft Rate of Return Guidelines*, October 2013.

NERA, *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.

guide to what adjustments to Lamberton's yield series one should make than an examination of eight or nine data points spread evenly over the entire sample period – which again starts in 1883. [143]

Fourth, the AER emphasises that the earlier data are of a lower quality than the later data. The AER states that:[144]

> 'there are significant problems with the earlier data, regardless of which adjustment is used.'

While a problem with the earlier data may be that it relies on a relatively small number of stocks, there are significant problems with relying solely on the later data. The most significant problem with relying solely on the later data is that the estimates of the *MRP* produced will be imprecise. The AER does not show this to be a problem in its decisions because it does not report the standard errors of its estimates. We recommend, as NERA does in its June 2015 report, that the AER report the standard errors of its *MRP* estimates. We note that Partington and Satchell endorse this recommendation.[145] We also recommend that the AER not report estimates of the *MRP* for overlapping periods. As NERA points out:[146]

> 'The AER in presenting estimates of the *MRP* provides estimates using both arithmetic means and geometric means over five overlapping periods – all of which include the period 1988 to 2014. [147] As we make clear, no weight should be placed on estimates that use geometric means. Besides this problem, however, the use of overlapping data amounts to placing more weight on estimates that use data from 1988 to 2014 than estimates that use earlier periods. While this may appear a sensible strategy, the impact will be to reduce the precision of the estimates.[148] As things stand, however, this cannot be seen from the AER's presentation of the results because the AER provides no standard errors. We recommend that the AER remove the column of geometric means from its table of results and replace the geometric means with a column of standard errors. This at least will show how imprecise are estimates that rely on a short time series of data. Even this change, however, will do nothing to stop the reader from treating the five overlapping periods as though they were independent – which, of course, they are not. So better still would be for the AER to report an estimate of the *MRP* that uses all of the data and, in addition, estimates that use non-overlapping sub-periods.'

Partington and Stachell also endorse this view of the problems with using overlapping data. Partington and Stachell state that:[149]

> 'we agree with NERA that the use of overlapping data reduces the precision of the estimates, and we also agree with NERA that the presentation of standard errors is desirable.'

While Partington and Satchell endorse NERA's views on the problems of using overlapping data and the reporting of standard errors, they do not endorse NERA's views on the use of arithmetic means in preference to geometric means in estimating the *MRP*. It is to their analysis of this issue to which we now turn.

[143] Fitzherbert, R., *Australian equity returns: Another look at the historical record*, JASSA, 2006, pages 20-25.

[144] AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 3: Rate of return*, October 2015, page 383.

[145] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 46.

[146] NERA, *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, page 28.

[147] AER, *Final Decision, Jemena Gas Networks (NSW) Ltd Access Arrangement 2015-20 Attachment 3 – Rate of return*, June 2015, page 331.

[148] See section 5 of our June 2013 report.

NERA, *The market, size and value premiums: A report for the ENA*, June 2013, pages 31-38.

[149] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 46.

3.2 Arithmetic versus Geometric Averaging

3.2.1 The AER never compounds an estimate of the *MRP*

In a March 2012 report NERA emphasises that an estimate of the long-run *WACC* that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will – so long as the other components of the *WACC* have been correctly computed and ignoring minor adjustments to the *RAB* and to the evolution of prices – produce an unbiased estimate of the revenue that the market will require in any one year, in the long run, on the *RAB*.[150] NERA also emphasises in the report that, in contrast, an estimate of the *WACC* that is in part based on an estimate of the *MRP* that places a positive weight on the geometric mean of a sample of annual excess returns to the market portfolio will produce a downwardly biased estimate of the return that the market requires in any one year.

While an estimate of the *WACC* compounded over more than one year, based on the arithmetic mean of a sample of annual excess returns to the market portfolio, will be biased, the AER, aside from some minor adjustments to the *RAB* and to the evolution of prices over the regulatory period, never compounds the *WACC* over more than one year.[151] Thus we recommend that for long-run estimates of the *MRP* the AER should rely solely on estimates that use arithmetic means and that the AER should place no weight on estimates that use geometric means. An estimate of the *MRP* that relies solely on estimates that use arithmetic means will provide a materially better estimate than an estimate that relies either fully or in part on geometric means.

We note that in independent advice provided at the request of the Queensland Competition Authority in July 2012, Lally, an adviser to the AER, reaches the same conclusion as we do and states that:[152]

> 'The AER's belief that geometric averages are useful apparently arises from a belief that there is a compounding effect in their regulatory process (AER, 2012, Appendix A.2.1), and therefore the analysis of Blume (1974) and Jacquier et al (2003) applies. However, I do not think that there is any such compounding effect in regulatory situations and the absence of a compounding effect leads to a preference for the arithmetic mean over the geometric mean.'
>
> 'If historical average returns are used, they should be arithmetic rather than geometric averages.'

The AER does not follow the advice that Lally provides in July 2012 and the advice provided by NERA in March 2012, February 2013, June 2013, February 2015 and June 2015 and instead relies on advice provided by McKenzie and Partington in December 2011 and February 2012 and Partington and Satchell in May 2015 and October 2015.[153] McKenzie and Partington and Partington and Satchell note that an estimate

[150] NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, pages 3-16 and pages 57-59.

[151] NERA's March 2012 report details the minor adjustments that the AER makes that involve compounding. These have to do with the timing of capital expenditure, difference between actual and forecast capital expenditure and the smoothing of prices.

[152] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 31-32.

[153] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 31-32.

McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011, pages 10-12.

McKenzie, M. and G. Partington, *Report to the AER: Supplementary report on the equity market risk premium*, SIRCA Limited, 22 February 2012, pages 5-9.

NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, pages 3-16 and pages 57-59.

NERA, *The cost of equity for a regulated energy utility: A report for Multinet*, February 2013, pages 48-53.

NERA, *The market, size and value premiums: A report for the ENA*, June 2013, pages 12-24.

NERA, *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, pages 25-30.

NERA, *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, pages 14-28.

Partington, G. and S. Satchell, *Report to the AER: Return of (sic) equity and comment on submissions in relation to JGN*, May 2015, pages 16-17.

of the *WACC*, compounded over more than one year, that is based on the arithmetic mean of a sample of annual excess returns to the market portfolio will be biased. McKenzie and Partington do not point to where in the regulatory process they believe the AER compounds an estimate of the *WACC* while Partington and Satchell rely on an argument that the AER made in 2012 that was shortly thereafter shown to be incorrect, separately, by the AER's adviser, Lally, and by NERA.

Partington and Satchell state in their October 2015 report that:[154]

> 'the point of setting the regulatory return is to select a rate at which new investment is a zero NPV activity. Underlying the rate setting, therefore, is the concept that the return is compounded.'

The AER, in its Roma to Brisbane April 2012 draft decision, states similarly that:[155]

> 'the building block model is a tool to achieve an outcome whereby the present value of expected revenue equals the present value of expected expenditure over the life of the regulated assets (the net present value (NPV)=0 condition or 'present value principle').'
>
> 'To determine a profile of revenues in which the NPV=0 outcome holds, an appropriate discount rate must be used, which requires the evaluation of an expected multi-period cost of equity.'

Lally, in his July 2012 report, and NERA, in its February 2013, June 2013, February 2015 and June 2015 reports, show that, while in ensuring the zero-NPV condition is satisfied the unknown discount rate or true *WACC* will be compounded, the allowed rate applied to the *RAB*, that is, an estimate of the *WACC*, will not be compounded. Thus Lally concludes that an estimate of the *WACC* is never compounded and that for the zero-NPV condition to be satisfied:[156]

> 'the expected value of the annual regulatory cost of capital must be equal to the true (but unknown) annual cost of capital.'
>
> 'The geometric mean fails this test while the arithmetic mean will satisfy it if annual returns are independent and drawn from the same distribution.'

NERA similarly concludes in its February 2013 report that:[157]

> 'we emphasise, as we make clear in our March 2012 report and Lally (2012) makes clear, that the AER never – ignoring minor adjustments to the *RAB* and to the evolution of prices – compounds an estimate of the *MRP*.
>
> 'while the utility's true *WACC* is compounded, the *WACC* is a parameter and not an estimate. In other words, the true *WACC* is not a random variable.'
>
> '[The zero-NPV condition requires] that the value for the one-period *WACC* that the regulator chooses … must be an unbiased predictor of the firm's true one-period *WACC*. An estimate of the *WACC* that is based, in part, on the arithmetic mean of a sample of annual excess returns to the market portfolio will produce an unbiased estimate of the true *WACC* and so will lead the present value principle to be on average satisfied. In contrast, an estimate of the *WACC* that is in part based on an estimate of the *MRP* that places a positive weight on the geometric mean of a sample of annual excess returns to the market portfolio will produce a downwardly biased estimate of the true *WACC* and will lead the present value principle to be on average violated.'

Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 44-46.

[154] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 44.

[155] AER, *APT Petroleum Pipeline Pty Ltd Access arrangement draft decision Roma to Brisbane Pipeline 2012–13 to 2016–17*, April 2012, pages 295-296.

[156] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, page 32.

[157] NERA, *The cost of equity for a regulated energy utility: A report for Multinet*, February 2013, pages 50, 52-53.

3.2.2 The lognormal distribution

The arithmetic mean of a sample of returns will provide an unbiased estimate of the unconditional expected return to an asset over a single period so long as the expectation exists.[158, 159] In contrast, the geometric mean of a sample of returns will generally provide a downwardly biased estimate of the unconditional expected return to an asset over a single period. Partington and Satchell, in their October 2015 report, make the surprising claim that if the gross return to an asset is lognormally and independently and identically distributed through time, then the arithmetic mean of a sample of T gross returns to the asset will provide an upwardly biased estimator of the expected gross return to the asset over a single period while the geometric mean will, for large T, provide an unbiased estimator.[160] The claim is surprising because the lognormal distribution plays a prominent role in economics and finance and the claim is incorrect.

If a random variable x is normally distributed, then $y = \exp(x)$ will be lognormally distributed.[161] While the random variable x can take on negative values, the random variable y cannot. So, as many quantities in economics and finance cannot take on negative values – for example, consumption and prices cannot be negative – the lognormal distribution has been widely employed in empirical and theoretical work.[162]

Partington and Satchell assume that:[163]

$$p(t+1) = \mu + p(t) + \sigma z(t+1), \qquad p(t+1) = \log(P(t+1)), \qquad z(t+1) \sim \mathrm{N}(0,1), \tag{15}$$

where $P(t+1)$ is the price of an asset at time $t+1$. The continuously compounded return to the asset is given by:

$$r(t+1) = p(t+1) - p(t) = \mu + \sigma z(t+1) \tag{16}$$

while the not continuously compounded gross return to the asset is given by:

$$R(t+1) = P(t+1)/P(t) = \exp\left(\mu + \sigma z(t+1)\right) \tag{17}$$

[158]The unconditional expectation of a random variable is the mean of its marginal probability distribution. The conditional expectation of a random variable, on the other hand, is the mean of the probability distribution of a random variable conditional on some other variable or variables. Our focus in this section of the report is on unconditional expectations.

There are random variables which have no means.The mathematical expectation of a Cauchy random variable, for example, does not exist.

[159]Define A to be the arithmetic mean of a sample of T gross annual returns, that is, let:

$$A = \sum_{t=1}^{T} \frac{R(t)}{T}$$

where $R(t)$ is one plus the rate of return to some asset from year t-1 to t. Then, so long as the expectation $\mathrm{E}(R(t))$ exists:

$$\mathrm{E}(A) = \mathrm{E}\left(\sum_{t=1}^{T} \frac{R(t)}{T}\right) = \sum_{t=1}^{T} \frac{\mathrm{E}(R(t))}{T} = \frac{T\,\mathrm{E}(R(t))}{T} = \mathrm{E}(R(t)),$$

In words, the arithmetic mean of a sample of returns will provide an unbiased estimate of the unconditional expected return to an asset over a single period so long as the expectation exists.

[160]Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 44-46.

[161]Maddala, G.S., *Econometrics*, McGraw-Hill, 1977, page 33.

[162]2013 Nobel prize-winner Hansen uses the assumption that gross returns are lognormal in some of his early work while 1997 Nobel prize-winner Merton uses the assumption in deriving a model to price options.

Hansen, L.P. and K.J. Singleton, *Stochastic consumption, risk aversion, and the temporal behaviour of asset returns*, Journal of Political Economy, 1983, pages 249-265.

Merton, R.C., *Theory of rational option pricing*, Bell Journal of Economics and Management Science, 1973, pages 141-183.

[163]Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 44.

It follows that the mean continuously compounded return to the asset is μ while the mean not continuously compounded gross return to the asset is:

$$E(R(t+1)) = \exp\left(\mu + \frac{1}{2}\sigma^2\right) \tag{18}$$

The latter result follows by inspection of the moment generating function of a normal random variable and is provided on page 15 of the graduate-level finance text of Campbell, Lo and MacKinlay.[164] Partington and Satchell assert instead, incorrectly, in their October 2015, report that:[165]

$$E(R(t+1)) = \exp(\mu) \tag{19}$$

The arithmetic mean of a sample of $T > 1$ gross returns is given by:

$$A = \sum_{t=1}^{T} \frac{R(t)}{T} \tag{20}$$

while the geometric mean is given by:

$$G = \left(\prod_{t=1}^{T} R(t)\right)^{1/T} \tag{21}$$

It follows that:

$$\mathrm{E}(A) = \mathrm{E}\left(\sum_{t=1}^{T} \frac{R(t)}{T}\right) = \sum_{t=1}^{T} \frac{\mathrm{E}(R(t))}{T} = \exp\left(\mu + \frac{1}{2}\sigma^2\right) = \mathrm{E}(R(t)) \tag{22}$$

and

$$\mathrm{E}(G) = \mathrm{E}\left(\left(\prod_{t=1}^{T} R(t)\right)^{1/T}\right) = \mathrm{E}\left(\exp\left(\frac{1}{T}\sum_{t=1}^{T} r(t)\right)\right) = \exp\left(\mu + \frac{1}{2T}\sigma^2\right) < \mathrm{E}(R(t)) \tag{23}$$

Thus, contrary to the claim that Partington and Satchell make, if the gross return to an asset is lognormal and independently and identically distributed through time, then the arithmetic mean of a sample of T gross returns to the asset will provide an unbiased estimator of the expected gross return to the asset over a single period while the geometric mean will provide a downwardly biased estimator. Moreover, the bias associated with the geometric mean will rise and not fall, as Partington and Satchell assert, as the sample size increases.

The bias associated with the geometric mean of a sample of returns as an estimator of the unconditional expected return to an asset over a single period is likely to be substantial. Using the data that Brailsford, Handley and Maheswaran (2012) supply and that we update, an estimate of the mean continuously compounded real return to the market from 1883 to 2014 is 7.20 per cent per annum while an estimate of the standard deviation of the return is 16.76 per cent per annum.[166,167] It follows that an estimate of the bias

[164] Campbell, J.Y., A.W. Lo and A.C. MacKinlay, *The econometrics of financial markets*, Princeton University Press, 1997, page 15.

[165] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 44.

[166] We assign a value of 35 cents to each dollar of imputation credits distributed.

[167] Brailsford, T., J. Handley and K. Maheswaran, *The historical equity risk premium in Australia: Post-GFC and 128 years of data*, Accounting and Finance, 2012, pages 237-247.

associated with the geometric mean of the real return to the market from 1883 to 2014 as an estimator of the unconditional expected real return to the market is, in per cent per annum:

$$100\times\left(\exp\left(\hat{\mu}+\frac{1}{2T}\hat{\sigma}^2\right)-\exp\left(\hat{\mu}+\frac{1}{2}\hat{\sigma}^2\right)\right)$$
$$=100\times\left(\exp\left(0.0720+\frac{0.1676^2}{2\times 132}\right)-\exp\left(0.0720+\frac{0.1676^2}{2}\right)\right)=1.51 \quad (24)$$

where a hat denotes an estimate.

Partington and Satchell also assert that the arithmetic mean:[168]

> 'is a noisy estimator.'

If the gross return to an asset is lognormal and independently and identically distributed through time, as Partington and Satchell assume, then the geometric mean of a sample of T gross returns to the asset will indeed provide a more precise estimate of the expected gross return to the asset over a single period than the arithmetic mean. The difference between the precision of the geometric mean and the precision of the arithmetic mean, however, is likely to be vanishingly small – in particular, relative to the bias associated with the geometric mean.

Again using results provided by Campbell, Lo and MacKinlay on page 15 of their text:[169]

$$\text{Var}(A)=\text{Var}\left(\sum_{t=1}^{T}\frac{R(t)}{T}\right)=\frac{1}{T^2}\sum_{t=1}^{T}\text{Var}(R(t))=\frac{1}{T}\exp\left(2\mu+\sigma^2\right)\left(\exp\left(\sigma^2\right)-1\right) \quad (25)$$

while

$$\text{Var}(G)=\text{Var}\left(\left(\prod_{t=1}^{T}R(t)\right)^{1/T}\right)=\text{Var}\left(\exp\left(\frac{1}{T}\sum_{t=1}^{T}r(t)\right)\right)$$
$$=\text{E}\left(\exp\left(\frac{2}{T}\sum_{t=1}^{T}r(t)\right)\right)-\left(\text{E}\left(\exp\left(\frac{1}{T}\sum_{t=1}^{T}r(t)\right)\right)\right)^2=\exp\left(2\mu+\frac{1}{T}\sigma^2\right)\left(\exp\left(\frac{1}{T}\sigma^2\right)-1\right) \quad (26)$$

It follows that an estimate of the standard error of the arithmetic mean of the real return to the market from 1883 to 2014 is, in per cent per annum:

$$100\times\left(\frac{1}{T}\exp\left(2\hat{\mu}+\hat{\sigma}^2\right)\left(\exp\left(\hat{\sigma}^2\right)-1\right)\right)^{1/2}$$
$$=100\times\left(\frac{1}{132}\exp\left(2\times 0.0720+0.1676^2\right)\left(\exp\left(0.1676^2\right)-1\right)\right)^{1/2}=1.60 \quad (27)$$

while an estimate of the standard error of the geometric mean of the real return from 1883 to 2014 is:

[168] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 44.

[169] Campbell, J.Y., A.W. Lo and A.C. MacKinlay, *The econometrics of financial markets*, Princeton University Press, 1997, page 15.

$$\exp\left(2\hat{\mu}+\frac{1}{T}\hat{\sigma}^2\right)\left(\exp\left(\frac{1}{T}\hat{\sigma}^2\right)-1\right)$$
$$=\exp\left(2\times 0.0720+\frac{0.1676^2}{132}\right)\left(\exp\left(\frac{0.1676^2}{132}\right)-1\right)=1.57 \quad (28)$$

Thus the standard error of the geometric mean is just three basis points lower than the standard error of the arithmetic mean. Again, the bias associated with the geometric mean is 151 basis points while the arithmetic mean is unbiased. Therefore, in our view, no weight should be placed on the geometric mean in estimating the long-run *MRP*. There is a very large cost to placing a weight on the geometric mean and a vanishingly small benefit to doing so.

4. Evidence from Independent Expert Reports

The AER has in the past endorsed the use of independent expert reports to compute an estimate of the *MRP*. For example, the AER states, in its September 2012 *Multinet Draft decision | 2013–17 | Draft decision appendices*, that:[170]

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

Similarly, McKenzie and Partington (2014) state that:[171]

> 'Expert reports provide one form of survey evidence on required rates of return and we have previously argued in favour of the use of survey evidence in assessing the market risk premium (see McKenzie and Partington, 2011). Therefore, we consider that expert's (sic) reports are one useful source of survey evidence when assessing the value of the market risk premium and the market return on equity.'

The use of independent expert reports circumvents a number of the problems associated with survey evidence. In particular:

- independent expert reports are typically made public and so it is not necessary to seek a response from each expert;
- many transactions require an independent expert report be produced;
- independent experts face strong incentives to provide accurate responses;
- it is clear from independent expert reports that the returns that they provide are to be used to determine a fair rate of return going forward rather than to evaluate past portfolio performance;
- independent experts generally state whether they place a value on imputation credits;
- independent experts generally state how they choose a value for the risk-free rate; and
- a time series of independent expert reports can be collected so that one can test propositions about the behaviour of expert assessments of the *MRP* through time.

Independent expert reports are prepared by accredited independent experts, working within an explicit regime of regulation, comprising both formal statutory rules and less formal guidelines, which require that the experts be accountable for the results of their work. Experts preparing independent expert reports which express an opinion as required by the Corporations Act or ASX Listing Rules should be experts in their field.

In this section, we present evidence on the *MRP* adopted by independent experts relative to the 10-year CGS yield in recent reports. We also provide evidence on the relation over time between the *MRP* adopted by independent experts and the CGS yield.

[170] AER, *Draft decision | Multinet 2013–17 | Draft decision appendices*, September 2012, page 32.
McKenzie, M. and G. Partington, *Supplementary report on the MRP*, SIRCA Limited, February 2012, page 17.

[171] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014, page 42.

4.1 Data

4.1.1 Description

We use independent expert reports issued between 1 January 2008 and 30 November 2015 that are published in the Connect 4 Expert Reports database. Like Ernst and Young, we examine only reports that:[172]

- include a valuation of a transaction and employ a discounted cash flow valuation method;
- use the Shape-Lintner CAPM to derive a cost of equity;
- provide sufficient information on how the cost of equity is estimated; and
- use the yield on a 10-year domestic government bond as a measure of the risk-free rate.

Using these criteria, 195 reports qualify that compute a cost of equity for 256 projects. Each independent expert report that uses the CAPM specifies three parameters:

- a risk-free rate or a range for the risk-free rate;
- an equity beta or a range for the equity beta; and
- an *MRP* or a range for the *MRP*.

It is important to note that the focus of independent expert reports is on what constitutes an appropriate overall *WACC* and not on what appropriate choices are for the individual parameters used to compute the *WACC*. For example, as we show, expert reports have in the recent past chosen values for the risk-free rate that lie above prevailing rates so as to lift the *WACC* that they compute. Consequently, in computing an estimate of the *MRP* that experts actually employ it is important to first determine what cost of equity they would use for the average firm, that is, for the market. To determine what cost of equity an expert would use for the market, we add the risk-free rate that the expert uses to his or her choice of an *MRP*. We determine the *MRP* that an expert would use by subtracting from this cost of equity the 10-year CGS yield.

An examination of the data reveals that for 110 of the 256 projects that experts consider between 1 January 2008 and 30 November 2015 a firm-specific premium is added to the cost of equity. An expert who adds a firm-specific risk premium to the cost of equity is not relying solely on the CAPM. McKenzie and Partington (2014) argue that many of the firm specific premiums that experts apply may be a way of adjusting for factors that should be reflected in forecasts of cash flows.[173] We exclude these uplifts from our analysis.

Where an independent expert sets a value for the *MRP*, calculates a value for the cost of equity and then subsequently revises the *WACC* produced by more than 25 basis points per annum, we examine the expert's report to determine whether there is clear evidence that the expert is either raising or lowering his or her assessment of the risk-free rate or adding or subtracting a premium for what he or she perceives to be higher or lower levels of market-wide risk. We uncover 16 projects and 14 reports where the experts make revisions to the cost of equity or *WACC* that they compute for reasons of this kind. For these projects and reports, we record both unadjusted and adjusted values for the *MRP*. For those projects and reports where adjustments are made but they are not for reasons of this kind, we compute only unadjusted estimates of the *MRP*.

Where an expert evaluates more than one project we compute for each project an unadjusted estimate of the mean return to the market and, in addition, adjusted estimates. The unadjusted estimates never differ across the projects that a report values but the adjusted estimates often do. In our empirical work, we use data for only one project per report and employ as a criterion that the project selected have the lowest adjusted return

[172] Ernst and Young, *Advice on aspects of the cost of equity, Victorian Gas Access Arrangement Review 2013-2017: A report for the APA Group, Envestra, Multinet and SP AusNet*, November 2012.

[173] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014, page 42.

to the market associated with it of the projects considered by the report. Thus we use a conservative selection criterion.

4.1.2 Imputation credits

The NER and NGR require that the estimated cost of corporate income tax for a network service provider be reduced to reflect a value attached to imputation credits created.[174] This requirement is necessitated by the use of a cost of equity that includes a value placed on credits distributed. We note, as do Ernst and Young, that we find no evidence that the values of the *MRP* that independent experts use are adjusted for the value that imputation credits provide to some investors.[175]

4.1.3 Uplifts

Like NERA in its April 2015 report, we use two ways of adjusting an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield.[176] The first method we label the NERA adjustment while the second method we label the Ernst & Young adjustment.

The NERA-adjusted value of the *MRP* is computed under the assumption that:

$$WACC(\text{final}) - WACC(\text{initial}) = \left(1 - \frac{D}{V}\right)\beta(MRP(\text{final}) - MRP(\text{initial})), \tag{29}$$

where D/V is the fraction of the firm's value made up of debt outstanding and β is the firm's equity beta. In other words, NERA assumes that the adjustment made is to the premium for bearing market risk. It follows that the NERA-adjusted value of the *MRP* is:

$$MRP(\text{final}) = MRP(\text{initial}) + \frac{(WACC(\text{final}) - WACC(\text{initial}))}{\left(1 - \frac{D}{V}\right)\beta} \tag{30}$$

The Ernst & Young-adjusted value of the *MRP* is computed under the assumption that:

$$WACC(final) - WACC(initial) = \left(1 - \frac{D}{V}\right)(r_f(final) - r_f(initial)), \tag{31}$$

where r_f is the risk-free rate. In other words, Ernst & Young assume that the adjustment made is to the risk-free rate. It follows that the Ernst & Young-adjusted value of the *MRP* is:

$$MRP(final) = MRP(initial) + \frac{(WACC(final) - WACC(initial))}{\left(1 - \frac{D}{V}\right)} \tag{32}$$

[174] Australian Energy Market Commission, *National Electricity Rules Version 77*, clause 6.5.3.

Australian Energy Market Commission, *National Gas Rules Version 28*, clause 87A.

[175] Ernst and Young, *Advice on aspects of the cost of equity, Victorian Gas Access Arrangement Review 2013-2017: A report for the APA Group, Envestra, Multinet and SP AusNet*, November 2012, page 15.

[176] NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015, pages 13-15.

To understand how we compute an adjusted value of the *MRP*, it will help to consider an example. The example we choose is the Grant Samuel August 2012 valuation for Hastings Diversified Utilities Fund. For the Grant Samuel August 2012 valuation for Hastings Diversified Utilities Fund:[177]

- the initial range for the *WACC* is 6.3 – 6.8 per cent per annum;
- the final range for the *WACC* is 8.0 – 8.5 per cent per annum;
- the range for the debt-to-value ratio is 45 – 55 per cent; and
- the range for the equity beta is 0.75 – 0.85.

Using the midpoints of each range produces a NERA-adjusted *MRP* in per cent per annum of:

$$6 + \frac{2 \times ((8.0 + 8.5) - (6.3 + 6.8))}{(0.45 + 0.55)(0.75 + 0.85)} = 10.25 \tag{33}$$

and an Ernst & Young-adjusted *MRP* in per cent per annum of:

$$6 + \left(\frac{(8.0 + 8.5) - (6.3 + 6.8)}{(0.45 + 0.55)} \right) = 9.40 \tag{34}$$

For the Grant Samuel August 2012 valuation for Hastings Diversified Utilities Fund, the unadjusted value of the *MRP* is 6 per cent per annum.[178]

4.1.4 Dependence

McKenzie and Partington (2014) correctly point out that experts typically author many reports and in these reports they may make similar choices. So while the experts themselves may be independent, the reports that they author need not be independent of one another.[179] In this report, we regress estimates, taken from independent expert reports, of the return required on the market portfolio in excess of the 10-year CGS yield on the CGS yield. So the problem that we face in drawing inference is that the disturbances from the regression need not be independently distributed of one another. In particular, the disturbance associated with one particular expert report will tend to be positively correlated with the disturbances associated with other reports written by the same expert – particularly reports written at about the same time.

We take into account the impact of the dependence that may exist on the standard errors that we compute by computing the square of the standard error of each regression using the formula:

$$\frac{1}{T} \sum_{s=1}^{T} \sum_{t=1}^{T} I(s,t) \hat{\varepsilon}(s) \hat{\varepsilon}(t), \tag{35}$$

where T is the sample size, $I(s,t)$ is an indicator variable that takes on the value one if the firm of experts that generates observation s is the same firm of experts that generates observation t and zero otherwise and $\hat{\varepsilon}(s)$ is the residual attached to observation s. A model in which dependence of this kind exists is known as a random effects model.[180] So in what follows we label results that use (35) to construct standard errors random effects or RE results.

Note that while reports produced by the same firm of experts often make similar choices, they typically do not make identical choices. To illustrate this empirical regularity, Table 3 below reports the adjustments to the

[177] Grant Samuel, *Independent expert's report: Pipeline Partners Offer*, 3 August 2012, page 8.

[178] Grant Samuel, *Independent expert's report: Pipeline Partners Offer*, 3 August 2012, page 7.

[179] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014, page 46.

[180] Wooldridge, J., *Introductory econometrics: A modern approach*, South-Western CENGAGE Learning, 2013, chapter 14.

10-year CGS yield made by the six reports written by BDO experts in 2015. Some of the variation in the adjustments made across reports can be explained by the fact that some of the reports were written by different experts working for the same firm. Table 3 shows, however, that it is also true that the same set of experts can make different choices in two reports written less than a couple of months apart. Thus while it would be untrue that the choices made by the six reports written by BDO can be viewed as having been made independently of one another, it is also untrue that the six reports should be treated as a single observation.

Table 3: BDO Adjustments to the Risk-Free Rate in 2015

Date	Company	Firm of experts	Experts	Adjustment to risk-free rate
26/02/2015	Coalspur Mines Ltd	BDO	Andrawes, Myers	0.83%
13/03/2015	CIC Australia Limited	BDO	Andrawes, Myers	0.25%
29/07/2015	Sirius Resources	BDO	Andrawes, Myers	0.08%
2/09/2015	Phoenix Gold Limited	BDO	Andrawes, Myers	0.70%
2/10/2015	Armour Energy	BDO	Sorbello, Birkett	2.01%
10/11/2015	Straits Resources Limited	BDO	Sorbello, Whittaker	1.76%

Note: Data are from the Connect-4 database and the RBA. The 10-year CGS yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls.

4.2 Summary Statistics

Table 4 provides some summary statistics and reveals a number of interesting empirical facts about these reports and projects.

First, Table 4 shows that across all reports experts set the risk-free rate 27 basis points on average above the 10-year CGS yield. Figure 7 plots the risk-free rates chosen by experts and the 10-year CGS yield against time. The figure makes clear that a tendency for experts to set the risk-free rate above the 10-year CGS yield is a relatively recent phenomenon.

Second, Table 4 reveals that around 38 per cent (74 of 195) of the reports make a firm specific adjustment to the cost of equity. McKenzie and Partington (2014) argue that many of these adjustments to the cost of equity are adjustments that should be made, not to the cost of equity, but to the cash flow forecasts the experts make.[181] As in NERA's 2013 and 2015 reports, we do not use these firm specific adjustments in forming an estimate of the *MRP*.[182] In other words, our tests, like those that NERA conducts, should be immune from the criticism that McKenzie and Partington make.

Third, Table 4 reveals that on average across reports independent experts set the *MRP* to be 6.27 per cent per annum relative to the risk-free rate that they choose. This implies that on average they set the *MRP* to be 6.27 + 4.73 – 4.46 = 6.54 per cent per annum relative to the 10-year CGS yield. Our analysis and the

[181] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014.

[182] NERA, *The market, size and value premiums: A Report for the ENA*, June 2013, pages 60-80.

NERA, *The relation between the market risk premium and risk-free rate: Evidence from independent expert reports: A report for United Energy*, April 2015, pages 13-15.

analysis that Ernst and Young (2012) indicates that the values of the *MRP* that independent experts use are not adjusted for the value that imputation credits provide to some investors.[183]

Table 4: Independent Expert Reports: Summary Statistics

	Projects	Reports
Number of observations	256	195
RFR_{IER}	4.76	4.73
RFR_{CGS}	4.49	4.46
Number of firm specific adjustments	110	74
Average firm specific adjustment	3.55	3.99
Beta	1.26	1.27
MRP_{IER}	6.28	6.27
Number of final adjustments described as market-wide	16	14

Note: Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls.

The ACT in its 2011 decision found that the AER should place a value of 35 cents on each one dollar of imputation credits distributed.[184] Brailsford, Handley and Maheswaran (2008) indicate that on average 75 per cent of dividends distributed are franked and the corporate tax rate is currently 30 per cent.[185, 186] So to take into account the value of credits distributed, we multiply a forecast of the dividend yield, measured as the ratio of dividends paid to start-of-year price, on the All Ordinaries by:

$$0.35 \times 0.75 \times \left(\frac{0.30}{1-0.30} \right) = 0.1125 \qquad (36)$$

The average dividend yield, measured as the ratio of dividends paid to start-of-year price, over the period 1883 to 2014, computed from the annual data that Brailsford, Handley and Maheswaran (2012) provide and that we adjust is 5.47 per cent.[187] Thus an estimate of the value arising from the distribution of imputation credits based on this average yield in per cent per annum is:

[183] Ernst and Young, *Advice on aspects of the cost of equity, Victorian Gas Access Arrangement Review 2013-2017: A report for the APA Group, Envestra, Multinet and SP AusNet*, November 2012, page 15.

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

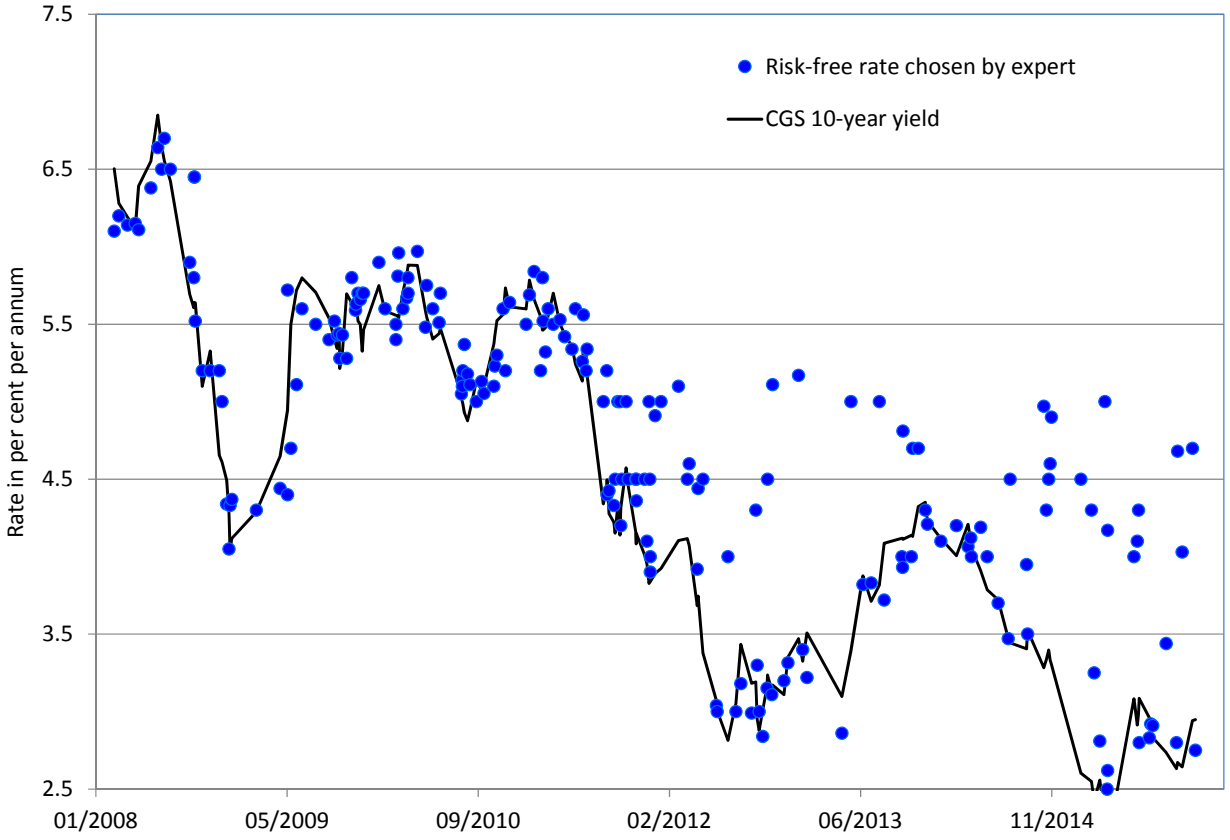
[185] Brailsford, T., J. Handley and K. Maheswaran, *Re-examination of the historical equity risk premium in Australia*, Accounting and Finance 48, 2008, page 85.

[186] Note that, empirically, the proportion of dividends that are franked, the distribution rate and the payout ratio take on similar values. They measure, however, different things. The distribution rate, also labelled the imputation credit payout ratio, measures the proportion of credits created that are distributed. The payout ratio, also labelled the dividend payout ratio, measures the proportion of earnings that are distributed as dividends.

[187] Brailsford, T., J. Handley and K. Maheswaran, *The historical equity risk premium in Australia: Post-GFC and 128 years of data*, Accounting and Finance, 2012, pages 237-247.

$$0.1125 \times 5.47 = 0.62 \quad (37)$$

Figure 7: Plot of Risk-Free Rates Chosen by Experts and 10-year CGS Yield against Time



Note: Data are from the Connect-4 database, the ASX and the RBA. The 10-year CGS yields are interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls.

The RBA reports that the dividend yield, measured as the ratio of dividends paid to end-of-year price, for the MSCI Australia index in November 2015 was 5.19 per cent.[188] Using the AER's assumption about the annual growth in dividends, this yield implies a value for the dividend yield, measured as the ratio of dividends paid to start-of-year price, of 5.19 × 1.06 = 5.50 per cent.[189] Thus an estimate of the value arising from the distribution of imputation credits based on this yield in per cent per annum is also, to two decimal places:[190]

$$0.1125 \times 5.50 = 0.62 \quad (38)$$

Note that if one were to assume that theta, the value that the market places on a dollar credit distributed, was higher, then an estimate of the value arising from the distribution of imputation credits based on the yield would also be higher. For example, were one to assume that theta is 0.60, then an estimate of the value arising from the distribution of imputation credits based on the yield in per cent per annum would be:[191]

[188] http://www.rba.gov.au/statistics/tables/pdf/f07.pdf

[189] AER, *Draft Distribution Determination Aurora Energy Pty Ltd 2012–13 to 2016–17*, November 2011, page 234.

[190] Brailsford, T., J. Handley and K. Maheswaran, *The historical equity risk premium in Australia: Post-GFC and 128 years of data*, Accounting and Finance, 2012, pages 237-247.

[191] A value for theta of 0.60 lies within the range of values for theta that the AER employs. See:

AER, *Preliminary decision Jemena distribution determination2016–20: Attachment 4: Value of imputation credits*, October 2015, page 18.

$$0.60 \times 0.75 \times \left(\frac{0.30}{1-0.30} \right) \times 5.50 = 1.06 \quad (39)$$

Thus the evidence provided by the summary statistics in Table 3 indicates that over the period 1 January 2008 to 30 November 2015 independent experts have set the *MRP* relative to the 10-year CGS yield on average to be 6.54 + 0.62 = 7.16 (7.60) per cent per annum inclusive of a value assigned to imputation credits – assuming a value for theta of 0.35 (0.60). We are primarily interested, however, in constructing an estimate of the *MRP*, based on an analysis of independent expert reports, which uses the current 10-year yield together with the relation that one observes between the *MRP* and the 10-year CGS yield to compute an estimate of the current *MRP*.

Finally, Table 4 shows that independent experts occasionally make market-wide adjustments to the cost of equity. We have examined each expert report to discover whether any adjustment has been to the cost of equity that is not firm specific and for which the expert provides a justification suggesting either that the expert wishes to use a higher value for the risk-free rate or wishes to use a higher value for the *MRP* than he or she might normally use. We have identified 14 reports that make adjustments of this kind and the adjustments are listed below in Table 5.

4.3 Regression Analysis

We use OLS to estimate the relation between the *MRP* chosen by independent experts and the 10-year CGS yield. While we use OLS to estimate the relation, however, we compute standard errors in three ways. First, we compute OLS standard errors. These standard errors will overstate significance if the disturbances attached to forecasts that a particular expert makes are positively correlated with one another. So second, we compute RE standard errors that allow the disturbances attached to forecasts that a particular expert makes to covary with one another. These RE standard errors may also overstate significance if there is a tendency for experts to simultaneously raise or lower their estimates of the *MRP* together relative to the forecasts that the regression which we use generates. Herding behaviour of this kind can give rise to serial dependence. So third, we use generalised method of moments (GMM) standard errors that are heteroskedasticity and autocorrelation consistent.

Our regressions use:

(i) an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield, $MRP_{IER} + RFR_{IER} - RFR_{CGS}$ [192]

(ii) an estimate taken from an independent expert report of the return required on the market portfolio in excess of the risk-free rate that the expert uses, MRP_{IER} and

(iii) the difference between a value for the risk-free rate taken from an independent expert report and the 10-year CGS yield, $RFR_{IER} - RFR_{CGS}$,

where the notation MRP_{IER} denotes a value for the *MRP* taken from an independent expert report, RFR_{IER}, a value for the risk-free rate taken from an independent expert report and RFR_{CGS}, the 10-year CGS yield. In particular, we examine whether the quantities (i) to (iii) are related to the 10-year CGS yield by regressing each quantity on the 10-year CGS yield. Table 5 provides the results of regressions that use unadjusted data.

[192] We compute the CGS yield by applying each day the AER's method of interpolation to compute the annual effective yield on a 10-year Commonwealth Government Security. The AER's method of interpolation is consistent with clause 6.5.2(d) of the National Electricity Rules.

Table 5: List of Market-Wide Adjustments

Date	Company	Expert	Rationale
3/08/2012	Hastings Diversified Utilities Fund	Grant Samuel	DGM, GFC, low interest rates, broker reports
3/10/2012	Duet Group	Grant Samuel	DGM, GFC, low interest rates, broker reports
7/12/2012	Australian Infrastructure Fund	Grant Samuel	DGM, GFC, low interest rates, broker reports
11/10/2013	Clough	Grant Samuel	DGM, GFC, low interest rates
5/11/2013	RHG	Deloitte	Additional market risk
21/01/2014	CFX Retail Property Trust	Grant Samuel	DGM, GFC, low interest rates, broker reports
3/03/2014	Envestra	Grant Samuel	DGM, GFC, low interest rates, broker reports
11/04/2014	Westfield	Grant Samuel	GFC, low interest rates
22/05/2014	David Jones Ltd	Grant Samuel	GFC, low interest rates, broker reports
5/09/2014	Wotif.com Holdings Ltd	Grant Samuel	GFC, low interest rates, broker reports
1/04/2015	TOLL	Grant Samuel	DGM, GFC, low interest rates
14/04/2015	Novion	Grant Samuel	DGM, GFC, low interest rates, broker reports
24/06/2015	Skilled Group	Grant Samuel	GFC, low interest rates, broker reports
29/09/2015	Asciano	Grant Samuel	DGM, GFC, low interest rates, broker reports

Note: Data are from the Connect-4 database, the ASX and the RBA. DGM denotes a concern that dividend growth model estimates exceed estimates generated by the Sharpe-Lintner CAPM and GFC denotes a concern that market risk is higher because of concern over the global financial crisis.

Table 6 shows that, regardless of the standard errors on which inference is based, one can reject the hypothesis at conventional levels of significance that an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield is unrelated to the CGS yield. The table shows that the reason for this relation is a tendency for experts to use a risk-free rate that exceeds the CGS yield when the CGS yield is low.

While Table 6 indicates that there is a negative relation between an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield and the CGS yield, the table does not provide evidence to support the conjecture that assessments of the return required on the market are unresponsive to shifts in the CGS yield. If assessments of the return required on the market were not responsive to shifts in the CGS yield, then the slope coefficient in the regression would be minus one and there is strong evidence against this hypothesis. The results indicate that as the 10-year CGS yield falls (rises) experts' estimates of the return required on the market portfolio in excess of the CGS yield rise (fall) – but by less than an offsetting amount. Put another way, the results indicate that as the 10-year CGS yield falls (rises) experts' estimates of the return required on the market portfolio also fall (rise) – but by a lesser amount. Specifically, the results indicate that if the 10-year CGS yield were to fall by 100 basis points, experts' (unadjusted) estimates of the return required on the market portfolio in excess of the CGS yield would rise by 24 basis points, meaning that experts' (unadjusted) estimates of the return required on the market portfolio would fall by 76 basis points.

The annual effective 10-year CGS yield on average over the 20 business days from 3 September 2015 to 30 September 2015 is 2.75 per cent per annum. Thus an estimate of the *MRP* that uses this yield and the results of Table 6 will be 7.618 – 0.241 × 2.75 = 6.96 per cent per annum, exclusive of a value assigned to imputation credits distributed. An estimate of the *MRP* that uses this yield and the results of Table 5 will be 6.96 + 0.62 = 7.58 (8.02) per cent per annum, inclusive of a value assigned to imputation credits distributed – where again we assume that theta is 0.35 (0.60).

Table 6: Unadjusted Expert Assessments of the *MRP* and the Risk-Free Rate

	Dependent variable: $MRP_{IER} + RFR_{IER} - RFR_{CGS}$		Dependent variable: MRP_{IER}		Dependent variable: $RFR_{IER} - RFR_{CGS}$	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
OLS	**7.618**	**-0.241**	**6.217**	0.011	**1.401**	**-0.253**
	(0.158)	(0.034)	(0.128)	(0.028)	(0.143)	(0.031)
RE	**7.618**	**-0.241**	**6.217**	0.011	**1.401**	**-0.253**
	(0.347)	(0.075)	(0.324)	(0.071)	(0.298)	(0.065)
GMM	**7.618**	**-0.241**	**6.217**	0.011	**1.401**	**-0.253**
	(0.178)	(0.037)	(0.152)	(0.033)	(0.192)	(0.037)

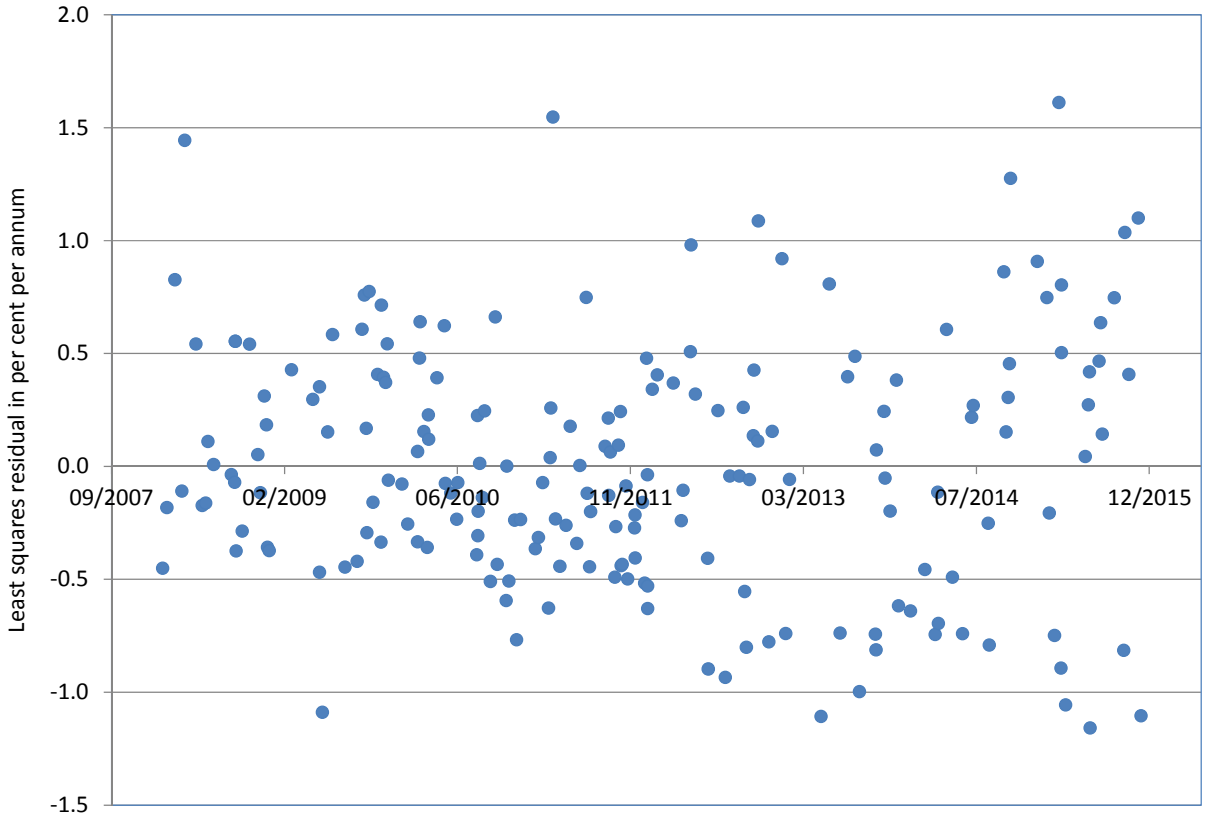
Note: Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year CGS yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls. The results are generated by regressing each dependent variable on RFR_{CGS}. OLS denotes ordinary least squares, RE, random effects and GMM the generalised method of moments. Standard errors are in parentheses. An estimate in bold differs significantly from zero at the 5 per cent level when inference uses the standard error that sits directly below the estimate.

McKenzie and Partington (2014) speculate that independent experts may herd – that is, they may exhibit a tendency to mimic the choices that other experts make.[193] Figure 8 below, which plots the residuals from a regression of an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield on the CGS yield provide no evidence of herding. In other words, the figure provides no evidence that the residuals are serially dependent. The first-order

[193] McKenzie, M. and G. Partington, *Report to the AER: Part A: Return on equity*, SIRCA, October 2014.

autocorrelation coefficient for the residuals is -0.03, which is not significantly different from zero. The figure also provides no evidence of outliers.[194]

Figure 8: Plot of OLS Residuals against Time



Note: Residuals are from an OLS regression of MRP_{IER} + RFR_{IER} - RFR_{CGS} against RFR_{CGS}. Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls. OLS denotes ordinary least squares.

Table 7 provides results for regressions that use the NERA-adjusted estimates of the *MRP*s assessed by experts. The table shows, again, that, regardless of the standard errors on which inference is based, one can reject the hypothesis at conventional levels of significance that an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield is unrelated to the CGS yield. The table shows, once more, that the reason for this relation is a tendency for experts to use a risk-free rate that exceeds the CGS yield when the CGS yield is low. There appears to be a relation between the *MRP* relative to the risk-free rate employed by an expert and the CGS yield but the evidence is not significant when an RE standard error is used.

The results indicate that if the 10-year CGS yield were to fall by 100 basis points, experts' (NERA-adjusted) estimates of the return required on the market portfolio in excess of the CGS yield would rise by 39 basis points, meaning that experts' (NERA-adjusted) estimates of the return required on the market portfolio would fall by 61 basis points.

[194] The Jarque-Bera statistic for a test of the null hypothesis that the residuals are normally distributed is 2.675 with a p-value of 0.263. Thus one cannot reject the null hypothesis that the residuals are normally distributed.

Again, the annual effective 10-year CGS yield on average over the 20 business days from 3 September 2015 to 30 September 2015 is 2.75 per cent per annum. Thus an estimate of the *MRP* that uses this yield and the results of Table 6 is 8.441 – 0.391 × 2.75 = 7.37 per cent per annum, exclusive of a value assigned to imputation credits distributed. An estimate of the *MRP* that uses this yield and the results of Table 6 will be 7.37 + 0.62 = 7.99 (8.43) per cent per annum, inclusive of a value assigned to imputation credits distributed – where, once more, we assume that theta is 0.35 (0.60).

Table 7: NERA-Adjusted Expert Assessments of the *MRP* and the Risk-Free Rate

	Dependent variable: $MRP_{IER} + RFR_{IER} - RFR_{CGS}$		Dependent variable: MRP_{IER}		Dependent variable: $RFR_{IER} - RFR_{CGS}$	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
OLS	**8.441**	**-0.391**	**7.039**	**-0.138**	**1.401**	**-0.253**
	(0.209)	(0.045)	(0.224)	(0.049)	(0.143)	(0.031)
RE	**8.441**	**-0.391**	**7.039**	-0.138	**1.401**	**-0.253**
	(0.242)	(0.053)	(0.443)	(0.096)	(0.298)	(0.065)
GMM	**8.441**	**-0.391**	**7.039**	**-0.138**	**1.401**	**-0.253**
	(0.250)	(0.050)	(0.301)	(0.059)	(0.192)	(0.037)

Note: Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year CGS yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls. The results are generated by regressing each dependent variable on RFR_{CGS}. OLS denotes ordinary least squares, RE, random effects and GMM the generalised method of moments. Standard errors are in parentheses. An estimate in bold differs significantly from zero at the 5 per cent level when inference uses the standard error that sits directly below the estimate.

Table 8 provides results for regressions that use the Ernst & Young-adjusted estimates of the *MRP*s assessed by experts. This table also shows that, regardless of the standard errors on which inference is based, one can reject the hypothesis at conventional levels of significance that an estimate, taken from an independent expert report, of the return required on the market portfolio in excess of the 10-year CGS yield is unrelated to the CGS yield. Again, the reason for this relation is a tendency for experts to use a risk-free rate that exceeds the CGS yield when the CGS yield is low. An apparent relation between the *MRP* relative to the risk-free rate employed by an expert and the CGS yield is not significant when an RE standard error is used.

The results indicate that if the 10-year CGS yield were to fall by 100 basis points, experts' (Ernst & Young-adjusted) estimates of the return required on the market portfolio in excess of the CGS yield would rise by 38 basis points, meaning that experts' (Ernst & Young-adjusted) estimates of the return required on the market portfolio would fall by 62 basis points.

The annual effective 10-year CGS yield on average over the 20 business days from 3 September 2015 to 30 September 2015 is 2.75 per cent per annum. Thus an estimate of the *MRP* that uses this yield and the results of Table 7 is 8.353 – 0.376 × 2.75 = 7.32 per cent per annum, exclusive of a value assigned to imputation credits distributed. An estimate of the *MRP* that uses this yield and the results of Table 7 will be 7.32 + 0.62 = 7.94 (8.38) per cent per annum, inclusive of a value assigned to imputation credits distributed – where we assume that theta is 0.35 (0.60).

Table 8: Ernst & Young-Adjusted Expert Assessments of the *MRP* and the Risk-Free Rate

	Dependent variable: $MRP_{IER} + RFR_{IER} - RFR_{CGS}$		Dependent variable: MRP_{IER}		Dependent variable: $RFR_{IER} - RFR_{CGS}$	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
OLS	**8.353**	**-0.376**	**6.952**	**-0.123**	**1.401**	**-0.253**
	(0.185)	(0.040)	(0.198)	(0.043)	(0.143)	(0.031)
RE	**8.353**	**-0.376**	**6.952**	-0.123	**1.401**	**-0.253**
	(0.191)	(0.042)	(0.394)	(0.086)	(0.298)	(0.065)
GMM	**8.353**	**-0.376**	**6.952**	**-0.123**	**1.401**	**-0.253**
	(0.220)	(0.045)	(0.267)	(0.053)	(0.192)	(0.037)

Note: Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls. The results are generated by regressing each dependent variable on RFR_{CGS}. OLS denotes ordinary least squares, RE, random effects and GMM the generalised method of moments. Standard errors are in parentheses. An estimate in bold differs significantly from zero at the 5 per cent level when inference uses the standard error that sits directly below the estimate.

4.4 Issues Raised by the AER

The AER raises a number of issues about NERA's use of independent expert reports and we address them here.

First, the AER states that:[195]

> 'It is not clear why NERA considers a valuer's estimate of (sic) market risk premium should be used to determine the valuer's estimated return on the market but should not be used to determine the valuer's estimated market risk premium. NERA instead prefers to use a measure of (sic) market risk premium defined as the valuer's estimated return on the market less the yield on Commonwealth government securities.'

NERA computes the *MRP* that an independent expert applies as the difference between the return to the market that the expert expects to see less the 10-year CGS yield because this is how the AER measures the *MRP*. The *MRP* is the difference between the expected return to the market and the risk-free rate and the AER uses the 10-year CGS yield to measure the risk-free rate.[196] Thus the AER measures the *MRP* as the difference between the expected return to the market and the 10-year CGS yield. NERA computes the *MRP* that an expert applies in exactly the same way.

Second, the AER states that:[197]

> 'It is not clear that valuation reports using risk free rate estimates that exceed yields on Commonwealth government securities is a widespread and persistent practice.'

[195] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 535.

[196] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 33.

[197] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 536.

This assertion is not supported by the evidence provided by Table 6 (and reproduced in Table 7 and Table 8). Table 6 shows that there is a significant negative relation between the difference between the risk-free rate that an expert uses and the 10-year CGS yield and the CGS yield. This evidence is statistically significant at conventional levels whether or not inference is based on OLS standard errors, RE standard errors or GMM standard errors. If using a risk-free rate that exceeds the CGS yield were not a widespread practice, one would not find evidence of this kind.

Third, the AER states that there is:[198]

> 'the possibility that valuers increase risk free rate estimates to reflect differences in the investment horizon relevant to the valuation report and the term of the Commonwealth government security used to proxy the risk free rate.'

The AER also provides an extract from a recent valuation report authored by KPMG that states that:[199]

> 'In Australia, the spot yield to maturity of 10 year Government Bonds has traditionally been accepted as a proxy for the risk free rate in determining a cost of equity under the CAPM. Further, the market in 10 year Government Bonds is liquid such that, in our view, the current yield on Government Bonds represents the best indicator of the risk free opportunity cost of the assets for the forthcoming 10 year period at any particular point in time.
>
> In our view, it is appropriate to take into account both the current yield on 10 year Australian Government Bonds, as well as the longer term expected yield in order to calculate a blended risk free rate over a time horizon appropriate to the underlying business operations of Prima. In this regard, we note that long term estimates of the yield on 10 year Australian Government Bonds approximated 5.5%. Adopting the spot yield of 2.64% for a period of 10 years, followed by 5.5% from year 11 onwards results in a blended risk free rate estimate of 4.3%.'

The AER raises an interesting conjecture and so we examine it in some detail. The AER's contention in a nutshell is that a steeper slope to the term structure will lead experts on average to use proxies for the risk-free rate that are more likely to exceed the 10-year CGS yield and a term structure that is less steeply sloped will lead experts on average to use proxies for the risk-free rate that are more likely to fall below the 10-year CGS yield. In what follows we examine:

- whether empirically the AER's argument can explain the magnitude of the adjustments that some experts make to the risk-free rate; and
- whether there is evidence that experts who make large adjustments cite a steeply sloped term structure as a reason for making the adjustments.

A good place to start is with the KPMG report to which the AER refers. In place of the 2.98 per cent per annum 10-year CGS yield prevailing on the date on which the report was written, 22 June 2015, KPMG uses a value of 4.3 per cent. Trial and error suggests that KPMG comes up with this figure by solving the following equation:[200]

$$\frac{1}{y} = \left[1 - \frac{1}{1.0264^{10}}\right] \times \frac{1}{0.0264} + \left[\frac{1}{1.0264^{10}}\right] \times \frac{1}{0.0550} \qquad (40)$$

The left-hand side of (40) is the value of a risk-free perpetual annuity that pays a dollar at the end of each year when the term structure is flat and the interest rate is y per annum. The right-hand side of (40) is the value of the same annuity when the one-year spot rate is 2.64 per cent per annum and one-year forward

[198] AER, *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015–20 Attachment 3 − Rate of return*, June 2015, page 536.

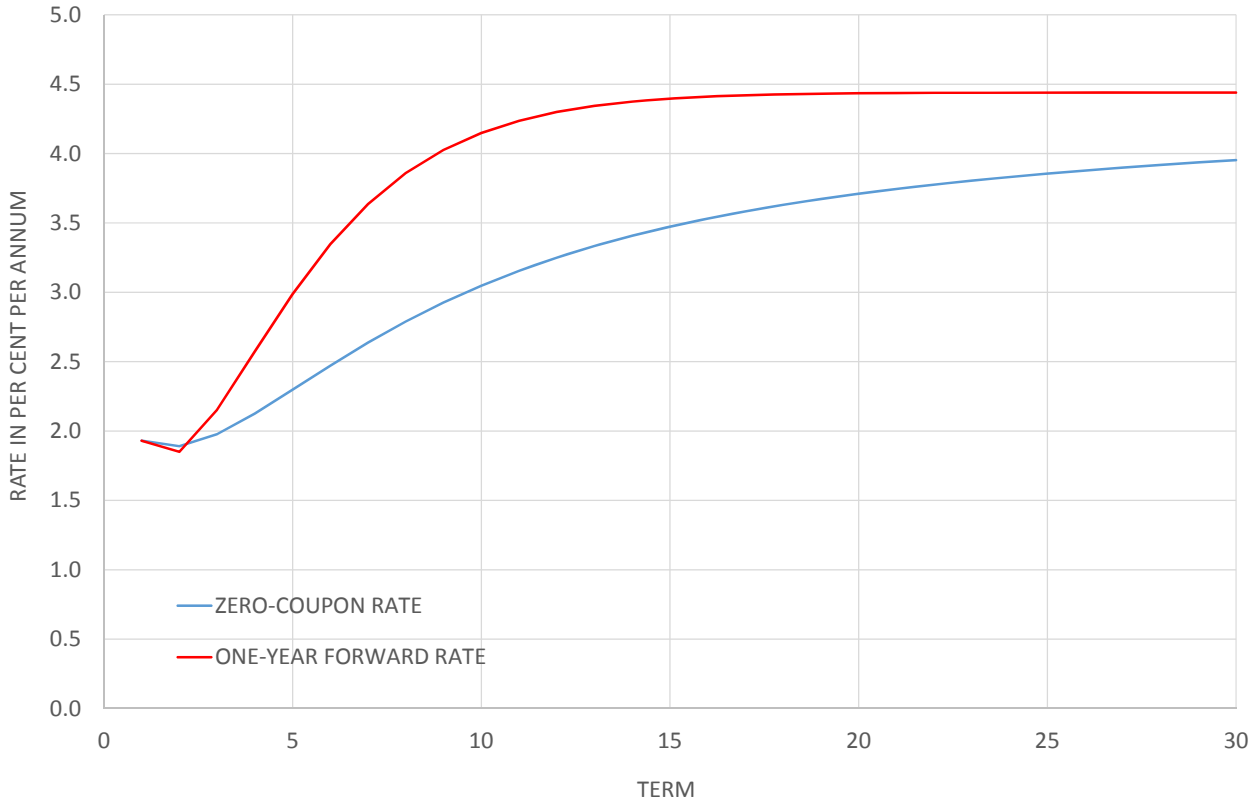
[199] KPMG, *Prima BioMed Limited: Independent Expert Report*, 22 June 2015, page 60.

[200] While the solution to (38) is 4.4 per cent per annum and not 4.3 per cent per annum, an examination of a closely related report, published by KPMG on 24 September 2012, to which we will return, suggests that KPMG does solve (38) but here makes a minor error.

rates are 2.64 per cent per annum up until year 10 and 5.50 per cent per annum from year 11 onwards. Thus trial and error suggests that KPMG computes the single rate which will discount the cash flows on a perpetual annuity back to the current value of the annuity when the term structure of forward rates looks like a step function.

There are three points to make about the way in which KPMG chooses a risk-free rate. First, the term structure of forward rates on 22 June 2015 does not resemble a step function. Figure 9 plots, for 22 June 2015, zero-coupon rates and one-year forward rates against term to maturity, where the rates are constructed using data from the RBA's file f16.xls and the method of Nelson and Siegel (1987).[201]

Figure 9: Plot of Zero-Coupon and One-Year Forward Rates against Term to Maturity, 22 June 2015



Note: Data are from the Connect-4 database, the ASX and the RBA. Zero-coupon CGS yields are computed using the RBA files f16.xls, f16hist.xls and f16hist2013.xls.

Second, from Figure 9, the one-year forward rate from year 11 onwards was well below 5.50 per cent per annum. It is clear from KPMG's report that 5.50 per cent is a forecast of the value that the 10-year yield will take in the long run and that this value sits above the forward 10-year yield quoted on 22 June 2015.

Third, an examination of KPMG's report indicates that KPMG considers the cash flows that it expects Prima to deliver to be far from risk-free. KPMG states that it uses discount rates of between 17 and 51 per cent per annum in evaluating Prima.[202] In addition, KPMG states that annual cash flow projections for Prima beyond 1H17 to FY30 are assumed to grow at a rate of just two per cent.[203] It follows that the present value of each cash flow that Prima is expected to deliver will fall much faster as the term of the cash flow increases than the present value of each cash flow thrown off by a risk-free annuity. With two per cent growth and a

[201] Nelson, C. and A. Siegel, *Parsimonious modeling of yield curves*, Journal of Business, 1987, pages 473-489.

[202] KPMG, *Prima BioMed Limited: Independent Expert Report*, 22 June 2015, page 66.

[203] KPMG, *Prima BioMed Limited: Independent Expert Report*, 22 June 2015, page 50.

discount rate of 17 per cent per annum, the present value of each cash flow will fall by 13 per cent per annum.[204] As a result, the duration of the cash flows to be thrown off by Prima will fall well below 10 years.[205] So it is evident that, in adjusting the 10-year CGS yield quoted on 22 June 2015, KPMG is using a rule of thumb. The adjustment that KPMG makes is not motivated by the idea that the duration of the cash flows that Prima expects to deliver exceeds 10 years.

To get a better understanding of what does motivate KPMG to make an adjustment to the CGS yield in its June 2015 report, it will be helpful to examine other reports produced by KPMG in which large adjustments are made to the yield. In addition, to get a broader understanding of what motivates other experts to make adjustments to the 10-year CGS yield, it will be helpful to examine reports produced by other firms of experts in which large adjustments are made to the yield.

Table 9 provides a list of all of the reports in which risk-free rates were used that differed from the 10-year CGS yield by at least 100 basis points. For each report, Table 9 provides the rationale provided by the expert or experts for using a risk-free rate differing from the 10-year CGS yield and the method used for determining the rate. All of the reports used risk-free rates lying above the 10-year CGS yield and the first of the reports was published in December 2011. Thus, as Figure 7 illustrates, it is only over the last four years that experts have used risk-free rates that differ substantially from the 10-year CGS yield.

There are three reports in which KPMG chooses a risk-free rate that differs by at least 100 basis points from the 10-year CGS yield. The first of these was published on 24 September 2012. In this report, KPMG states that:[206]

> 'Recent market volatility and risk aversion by investors, driven by macro-economic uncertainty, particularly in Europe, has contributed to bond yields trading at historical lows. Further, market evidence indicates that bond yields and the MRP are strongly inversely correlated. In this context, it is important that any assessment of the risk-free rate should be made with respect to the position adopted in deriving the MRP, and there are two relevant options available when undertaking this exercise:
>
> - adopt a historical MRP as a proxy for the expected MRP and adjust the spot risk-free rate to take into account the relationship highlighted above; or
> - adopt the spot risk-free rate and adjust the MRP for the perceived additional risks attaching to equity investments implicit from historically low (or high as the case may be) risk-free rates to reflect the current investment environment and the inverse relationship between the two variables.
>
> For the purposes of our analysis, we have adopted the former approach and applied a historical estimate of the MRP and adjusted the risk-free rate accordingly.'

KPMG is clear here that it believes that bond yields and the *MRP* are strongly negatively related and that it views adjustments to the CGS yield and adjustments to the *MRP* as two alternative methods for dealing with the problems arising from yields that are trading at historical lows.

[204] They are expected to grow each year by two per cent and the discount rate is at least 17 per cent per annum and so the present value of each cash flow will fall by at least 100 × (1 – 1.02/1.17) = 13 per cent per year.

[205] The duration of a growing perpetuity is (1 + r)/(r – g) where r is the discount rate and g is the rate at which the perpetuity grows. So the duration of a perpetuity that grows at two per cent per annum will be no more than 7.8 years if r is no less than 17 per cent per annum. See:

http://pages.stern.nyu.edu/~gyang/foundations/sample-final-solutions.html

[206] KPMG, *Consolidated Media Holdings Limited: Independent Expert Report*, 24 September 2012, pages 91-92.

Table 9: Rationales Given for Large Risk-Free Rate Uplifts

Date	Ticker	Expert	Rationale	Method
20/12/2011	LLA	Grant Thornton	Given the current volatility in the global economy due to the uncertainty associated with European debt markets, we have observed the yield on the 10-year Australian Commonwealth Government Bond over a longer period. [Page 68]	Based on the average yield for the period 1 January 2011 to the 16 December 2011, we have adopted (sic) risk free rate of 5%. [Page 68]
5/01/2012	KME	Crowe Horwath	(The risk-free rate was measured as) the average risk free rate for the 2011 calendar year, being the average daily 10 year Australian Government Bond Rate during the period 1 January 2011 to 16 December 2011 of 4.91%. [Page 39]	(The risk-free rate was measured as) the average risk free rate for the 2011 calendar year, being the average daily 10 year Australian Government Bond Rate during the period 1 January 2011 to 16 December 2011 of 4.91%. [Page 39]
20/01/2012	OOH	Grant Thornton	Given the current volatility in the global economy due to the uncertainty associated with European debt markets, we have observed the yield on the 10-year Australian Commonwealth Government Bond over a longer period. [Page 147]	Based on the average yield for the period 1 January 2011 to the 12 December 2011, we have adopted (sic) risk free rate of 5%. [Page 147]
9/05/2012	NBS	Grant Thornton	Given the current volatility in the global economy due to the uncertainty associated with European debt markets, we have observed the yield on the 10-year Australian Commonwealth Government Bond over a longer period. [Page 74]	Based on the average yield for the period 1 April 2011 to the 2 April 2012, we have adopted (sic) risk free rate of 4.5%. [Page 74]
13/07/2012	NGF	Grant Thornton	Given the current volatility in the financial markets, we have placed more emphasis on the risk free rate observed over a longer period of time. [Appendix B]	(W)e have adopted the risk free rate of 4%, which is primarily based on the 180 days yield and 360 days yield on 10-year Australian Commonwealth Government Bond. [Appendix B]
24/09/2012	CMJ	KPMG	Recent market volatility and risk aversion by investors, driven by macro-economic uncertainty, particularly in Europe, has contributed to bond yields trading at historical lows. Further, market evidence indicates that bond yields and the MRP are strongly inversely correlated. In this context, it is important that any assessment of the risk-free rate should be made with respect to the position adopted in deriving the MRP, and there are two relevant options available when undertaking this exercise: • adopt a historical MRP as a proxy for the expected MRP and adjust the spot risk-free rate to take into account the relationship highlighted above; or • adopt the spot risk-free rate and adjust the MRP for the perceived additional risks attaching to equity investments implicit from historically low (or high as the case may be) risk-free rates to reflect the current investment environment and the inverse relationship between the two variables. For the purposes of our analysis, we have adopted the former approach and applied a historical estimate of the MRP and adjusted the risk-free rate accordingly. [Pages 91-92]	In our view it is appropriate to take into account both the current yield on 10 year Commonwealth Government Bonds as well as the longer term expected yield in order to calculate a blended risk-free rate over a time horizon appropriate to the underlying business operations of both Foxtel and FOX SPORTS. In this regard, we note that Oxford Economics estimates the yield on 10 year Commonwealth Government Bonds to approximate 5.1% from 2016 onwards whilst BIS Schrapnel's average long term view between 2022 and 2027 is 4.9%. Adopting the spot risk-free rate of 3.0% for a period of 10 years, followed by 5.0% from year 11 onwards (reflecting the average long term view of Oxford Economics and BIS Schrapnel), results in a blended risk-free rate estimate of 4.3% over the life of the underlying investments. [Page 92]

Table 9 (continued): Rationales Given for Large Risk-Free Rate Uplifts

Date	Ticker	Expert	Rationale	Method
25/10/2012	SMR	Lonergan & Edwards	The currently prevailing 10 year Commonwealth Government bond rate is well below historical levels and reflects, inter alia, the weak outlook for global economic growth (and its impact on the outlook for the Australian economy) and the effect of quantitative easing measures by major overseas central banks. At the same time spreads have generally increased to offset the impact of the lower risk-free rate. Accordingly, in our view the application of current (low) government bond yields and long-term average market risk premiums is inappropriate in the context of determining long-term required equity rates of return (discount rates). [Page 46]	As it is difficult to reliably measure short-term movements in the market risk premium we have therefore increased the risk-free rate for the purpose of estimating required equity rates of return only. [Page 46]
7/11/2012	IGR	Ernst & Young	We believe that the current risk free rate (usually estimated with reference to the 10 year Government bond rate) is at historically low levels. Most market observers regard this as inconsistent with current share prices, the observed volatility in markets and general economic uncertainty. In response, many valuers have either used a normalised risk free rate, increased their estimates of the market risk premium or have included an additional risk factor in their calculations of the cost of equity. Our preference is to normalise the risk free rate to best reflect the longer term position. [Page 84]	Based on a historical analysis of the risk free rate using the 10 year Australian Government bond rate, a long term range of 5.2% to 5.4% appears appropriate. On this basis, in determining an appropriate risk free rate we have considered the 10 year Australian Government bond yield as at 31 August 2012 of 3.11% and add a further 2.00%. These inputs result in a risk free rate of 5.11%. [Page 84]
14/01/2013	MAH	Ernst & Young	We believe that the current risk free rate (usually estimated with reference to the 10 year Government bond rate) is at historically low levels. Most market observers regard this as inconsistent with current share prices, the observed volatility in markets and general economic uncertainty. In response, many valuers have either used a normalised risk free rate, increased their estimates of the market risk premium or have included an additional risk factor in their calculations of the cost of equity. Our preference is to normalise the risk free rate to best reflect the longer term position. [Page 56]	Based on a historical analysis of the risk free rate using the 10 year Australian Government bond rate, a long term range of 5.2% to 5.4% appears appropriate. On this basis, in determining an appropriate risk free rate we have considered the 10 year Australian Government bond yield as at 30 December 2012 of 3.17% and add a further 2.00%. These inputs result in a risk free rate of 5.17%. [Page 56]
31/05/2013	PLY	Grant Thornton	Given the unprecedented, historically low Australian Commonwealth Government Bond yields as a result of the volatility in global equity markets and debt crisis in Europe, we believe utilising a long-term average yield is reasonable given the current economic climate. [Page 98]	(W)e have adopted a risk free rate of 5.0%, which is consistent with our view of an appropriate long-term risk free rate estimate. [Page 98]
13/08/2013	APK	Grant Thornton	We have adopted the risk free rate of 5%, which is primarily based on the 10-day (sic) average yield as at 16 July 2013. [Page 139]	We have adopted the risk free rate of 5%, which is primarily based on the 10-day (sic) average yield as at 16 July 2013. [Page 139]
21/07/2014	CTY	Lonergan & Edwards	(W)e believe current yields (notwithstanding their long-term nature) remain at unsustainably low levels due to, inter alia, the effect of quantitative easing measures by major overseas central banks to stimulate economic activity. [Page 40]	(We have applied) a risk-free rate of 4.5% per annum. This exceeds the average yield to maturity currently prevailing on 20 year Australian Government bonds (of approximately 4.0% per annum as at 30 June 2014) as we believe current yields (notwithstanding their long-term nature) remain at unsustainably low levels. [Page 40]

Table 9 (continued): Rationales Given for Large Risk-Free Rate Uplifts

Date	Ticker	Expert	Rationale	Method
17/10/2014	MWS	William Buck	When valuing a long life asset, the best approximation of the risk free rate … is a Government borrowing instrument with a term which most closely matches the term of the cash flows to which it will be applied. [Page 48]	The risk free rate has therefore been based on the yield on 10 year marketable bonds issues by the Government of Australia as at 30 June 2014 of 4.97%. [Page 48]
30/10/2014	NXS	Lonergan & Edwards	(W)e believe current yields (notwithstanding their long-term nature) remain at unsustainably low levels due to, inter alia, the effect of quantitative easing measures by major overseas central banks to stimulate economic activity. [Page 48]	We have applied a risk-free rate of 4.5% per annum. This exceeds the average yield to maturity currently prevailing on 20 year Australian Government bonds (of approximately 3.79% per annum as at 20 October 2014) as we believe current yields (notwithstanding their long-term nature) remain at unsustainably low levels. [Page 48]
3/11/2014	ARF	KPMG	The risk free rate has been selected by reference to the current spot yield and long term forecast yields on 10 year Australian Government bonds. [Page 43]	We have adopted 4.6% as an appropriate risk free rate, which represents a blended long term risk free rate. [Page 43]
6/11/2014	OTE	RSM Bird Cameron	We have used the 10-year bond rate as this is typically used as a proxy for the long-term risk-free rate. [Page 42]	We have assumed a risk free rate of 4.90% being the average yield on the 10-year Australian Government Bond for the last 10 years, as published by the RBA. [Page 42]
22/01/2015	MEB	Grant Thornton	Given the current volatility in the financial markets, we have placed more emphasis on the risk free rate observed over a longer period of time. [Page 51]	(W)e have adopted the risk free rate of 4.5%, which is based on the 5 year average yield on the 10 year Australian Government Bond. [Page 51]
19/02/2015	MRN	Grant Thornton	We selected the 5 year trading rate due to high volatility in global equity markets over the past several years and subsequently, the potential distortion possible with recent quantitative easing. [Page 79]	We have adopted a risk free rate of … 4.31% based on the previous 5 year trading of the 10 year Australia Government Bonds' yield. [Page 79]
26/03/2015	WCB	Grant Thornton	Given the unprecedented, historically low Australian Commonwealth Government Bond yields as a result of the volatility in global equity markets and debt crisis in Europe, we believe utilising a long-term average yield is reasonable given the current economic climate. [Page 42]	(W)e have adopted a risk free rate of 5.0%, which is consistent with our view of an appropriate long-term risk free rate estimate. [Page 42]
2/04/2015	PAY	HanrickCurran	The current risk free rate (spot rate) is at or near an historical low and in view of the long term nature of the assets being valued is unrepresentative of the risk free rate. [Page 62]	(W)e have adopted the historical 5 year average ten-year Australian Government Bond rate as a proxy for the risk free rate. [Page 62]
19/06/2015	RTA	Grant Thornton	Given the noises nature around the existing short-term risk free rate, we have placed more emphasis on the risk free rate observed over a longer period of time. [Page 60]	(W)e have adopted the risk free rate of 4.07%, which is based on the 5 year average yield on the 10 year Australian Government Bond. [Page 60]
22/06/2015	PRR	KPMG	In our view, it is appropriate to take into account both the current yield on 10 year Australian Government Bonds, as well as the longer term expected yield in order to calculate a blended risk free rate over a time horizon appropriate to the underlying business operations of Prima. [Page 60]	(W)e note that long term estimates of the yield on 10 year Australian Government Bonds approximated 5.5%. Adopting the spot yield of 2.64% for a period of 10 years, followed by 5.5% from year 11 onwards results in a blended risk free rate estimate of 4.3%. [Page 60]

Table 9 (continued): Rationales Given for Large Risk-Free Rate Uplifts

Date	Ticker	Expert	Rationale	Method
2/10/2015	AJQ	BDO	In our view, an appropriate risk free rate to use in calculating the cost of equity capital for the Roma Shelf Assets is the rate on 10 year Australian Government Bonds. [Page 66]	As at 10 September 2015, the average 10 year rate on 10-year Australian Treasury Bonds was 4.68%. [Page 66]
14/10/2015	MOY	Grant Thornton	Given the volatility in the Australian financial markets, we have had more regard to the average risk free rate observed over a longer period of time. [Page 64]	(W)e have adopted the risk free rate of 4.03%, which is primarily based on the 5 year average yield on the 10-year Australian Government Bond. [Page 64]
10/11/2015	SRQ	BDO	We note that Commonwealth Treasury bond yields are currently at historically low levels. In our view, the current low yield levels may not persist over the medium to long term. [Page 60]	(I)n our view an appropriate risk free rate to use in calculating the cost of equity capital for Straits is the 10 year average of the rate on 10-year Commonwealth Treasury Bonds. [Page 60]

Note: Data are from the Connect-4 database.

Other experts provide a similar rationale for using a value for the risk-free rate that sits above the 10-year CGS yield. For example, Lonergan and Edwards state in their 25 October 2012 report that:[207]

> 'The currently prevailing 10 year Commonwealth Government bond rate is well below historical levels and reflects, inter alia, the weak outlook for global economic growth (and its impact on the outlook for the Australian economy) and the effect of quantitative easing measures by major overseas central banks. At the same time spreads have generally increased to offset the impact of the lower risk-free rate. Accordingly, in our view the application of current (low) government bond yields and long-term average market risk premiums is inappropriate in the context of determining long-term required equity rates of return (discount rates).'
>
> 'As it is difficult to reliably measure short-term movements in the market risk premium we have therefore increased the risk-free rate for the purpose of estimating required equity rates of return only.'

As another example, Ernst and Young state in their 7 November 2012 report that:[208]

> 'We believe that the current risk free rate (usually estimated with reference to the 10 year Government bond rate) is at historically low levels. Most market observers regard this as inconsistent with current share prices, the observed volatility in markets and general economic uncertainty. In response, many valuers have either used a normalised risk free rate, increased their estimates of the market risk premium or have included an additional risk factor in their calculations of the cost of equity. Our preference is to normalise the risk free rate to best reflect the longer term position.'

Aside from KPMG, there is only one other firm of experts that has published a report that might be interpreted as suggesting that it uses a risk-free rate that is at least 100 basis points higher than the 10-year CGS yield because of concerns over the slope of the term structure. In the only report that HanrickCurran has written that is in our database, the firm of experts states that:[209]

> 'The current risk free rate (spot rate) is at or near an historical low and in view of the long term nature of the assets being valued is unrepresentative of the risk free rate.'

[207] Lonergan & Edwards, *Stanmore Coal: Independent Expert Report*, 25 October 2012, page 46.

[208] Ernst & Young, *Integra Mining: Independent Expert Report*, 7 November 2012, page 84.

[209] HanrickCurran, *PAYCE Consolidated Limited: Independent Expert Report*, 2 April 2015, page 62.

HanrickCurran uses a risk-free rate for computing the cost of equity of 4.17 per cent per annum, a debt-to-equity ratio for PAYCE of 100 per cent and a *WACC* of 6.61 per cent per annum for PAYCE rental property. Thus if one defines *y* to be the risk-free rate that HanrickCurran chooses, then the firm of experts determines the *WACC*, in per cent per annum, to be:[210]

$$0.5 \times y + (6.61 - 0.5 \times 4.17) = 0.5 \times y + 4.53 \quad (41)$$

HanrickCurran also states that it assumes that there will be:[211]

> '(g)rowth in the forecast period of 2.5% in respect of property rental and in line with inflation thereafter.'

The term structure of zero-coupon rates on 2 April 2015 was upward sloping. We employ zero-coupon rates constructed using data from the RBA's file f16.xls and the method of Nelson and Siegel (1987) to determine the present value, on 2 April 2015, of a perpetuity that is expected to deliver an annual payment that grows at 2.5 per cent per annum.[212] We then solve for the single value for *y* that will deliver the same present value. This single value for *y* turns out to be 3.11 per cent which, while higher than the 10-year CGS yield of 2.31 per cent per annum quoted on 2 April 2015, is well below the value for the risk-free rate that HanrickCurran chooses of 4.17 per cent. This casts doubt on the idea that HanrickCurran chooses a higher value for the risk-free rate solely because of concerns about the slope of the term structure.

We conclude from an examination of the reports in which large adjustments are made to the 10-year CGS yield that the AER's term structure hypothesis, while interesting, has little support.

4.5 Issues Raised by the AER's Advisers

4.5.1 Allocating weights

Partington and Satchell note that some firms of experts write more reports than others and suggest that instead of placing an equal weight on each report less weight should be placed on reports written by firms of experts who write many reports and more weight should be placed on firms that write few reports.[213] In particular, they argue that firms that write many reports may employ estimates that are no better than firms that write few reports. In addition, Partington and Satchell note that two firms are responsible for 43 per cent of the uplifts to the 10-year CGS yield that exceed 50 basis points between 2010 and 2014.[214]

We update these results. There are 23 firms that write 195 reports between 2008 and 2015. We find that there are 14 firms that write 48 reports in which an adjustment is made to the 10-year CGS yield that exceeds 50 basis points between 2008 and 2015. We find that there are 19 firms that write 147 reports in which an adjustment is not made to the 10-year CGS yield that exceeds 50 basis points over this period. Two firms, BDO and Grant Thornton, together write 19 of the reports – that is, 40 per cent of the reports – in which an adjustment is made that exceeds 50 basis points. The same two firms also together write 30 of the reports – that is, 20 per cent of the reports – in which an adjustment that exceeds 50 basis points is not made.

These statistics illustrate that adjustments to the CGS yield that exceed 50 basis points are made by many firms and that many firms also make from time to time either no adjustment or an adjustment that does not exceed 50 basis points. The statistics also indicate that the same firm of experts will in some reports make adjustments that exceed 50 basis points and in other reports make either no adjustment or adjustments that do not exceed 50 basis points. It is this variation in behaviour across experts and, for a single firm of experts,

[210] HanrickCurran, *PAYCE Consolidated Limited: Independent Expert Report*, 2 April 2015, pages 62-64.

[211] HanrickCurran, *PAYCE Consolidated Limited: Independent Expert Report*, 2 April 2015, page 64.

[212] Nelson, C. and A. Siegel, *Parsimonious modeling of yield curves*, Journal of Business, 1987, pages 473-489.

[213] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 32-33.

[214] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, page 37.

through time that enables us to produce estimates of the relation between the *MRP* employed by experts and the CGS yield that are statistically significant.

It is not clear that firms that write many reports employ estimates that are no better than firms that write few reports and it is also not clear that estimates that place an equal weight on each firm of experts rather than on each report will be more reliable. Nevertheless, in Table 10 below we report the means computed across the 23 firms of experts of:

- RFR_{IER}, the risk-free rate chosen by an independent expert;
- RFR_{CGS}, the 10-year CGS yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls; and
- MRP_{IER}, the *MRP* chosen by an independent expert relative to the risk-free rate chosen by the expert.

To compute these means, first, for each firm of experts and for each variable, we compute the mean of the variable across all reports written by the firm and then second, for each variable, we compute the mean of the 23 firm means.

Table 10 indicates that computing the means in this way widens the gap between the mean of the risk-free rate chosen by a firm of experts and the mean of the CGS yield. Table 4, which places an equal weight on each report, reports a gap of 27 basis points while Table 10 reports a gap of 33 basis points.

Table 10 also indicates that computing the means in this way raises an estimate of the *MRP* computed relative to the risk-free rate chosen by an expert. Table 4, which again places an equal weight on each report, reports an estimate of the *MRP* computed relative to the risk-free rate chosen by an expert of 6.27 per cent per annum, exclusive of a value assigned to imputation credits. Table 10 reports an estimate of the *MRP* computed relative to the risk-free rate chosen by an expert of 6.38 per cent per annum, exclusive of a value assigned to imputation credits. Inclusive of a value of 35 (60) cents assigned to a one-dollar imputation credit distributed, an estimate of the *MRP* computed relative to the risk-free rate chosen by an expert is 6.38 + 0.62 = 7.00 (7.44) per cent per annum. This estimate does not use the uplifts listed in Table 5 nor does it use information about the relation between the *MRP* employed by experts and the 10-year CGS yield.

Table 10: Independent Expert Reports: Summary Statistics Based on Firm Means

Number of firms	23
RFR_{IER}	4.68
RFR_{CGS}	4.35
MRP_{IER}	6.38

Note: Data are from the Connect-4 database, the ASX and the RBA. MRP_{IER} is the MRP chosen by the independent expert, RFR_{IER} is the risk-free rate chosen by the independent expert and RFR_{CGS} is the 10-year yield interpolated from the RBA files f16.xls, f16hist.xls and f16hist2013.xls.

4.5.2 Term of the risk-free rate

Partington and Satchell provide a framework that they suggest can be used to determine how to blend short-term risk-free rates and long-term risk-free rates in setting a cost of equity.[215] Their analysis is based on a model provided by Satchell in recent work with Muijsson and Fishwick.[216] Muijsson, Fishwick and

[215] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 53-55.

[216] Muijsson, C., E. Fishwick and S. Satchell, *Taking the art out of smart beta*, University of Sydney, September 2014, pages 22-24.

Satchell (2014) state that their model is motivated by the preferred habitat hypothesis. The preferred habitat hypothesis of Nobel prize-winner Modigliani and Sutch (1966) argues that some investors may have a preference for short-term bonds while other investors may have a preference for long-term bonds.[217] The first set of investors view long-term bonds as risky while the second set of investors view short-term bonds as risky. In the model of Muijsson, Fishwick and Satchell, though, there is no uncertainty about bond returns – that is, as far as bonds go, in their model there is no risk. As Modigliani and Sutch make clear a key ingredient necessary for the preferred habitat hypothesis to hold is uncertainty about bond returns.[218] With no uncertainty about bond returns, the returns on bonds of different maturities must match each other over any particular horizon to ensure arbitrage opportunities are absent.[219]

As Ingersoll (1987) states:[220]

> 'The liquidity preference and preferred habitat theories explain differences among expected rates of return on bonds of different maturities by risk arguments. The preferred habitat theory argues that we cannot determine which bonds are riskier until we know the investment horizons of investors. For example, an investor who wishes to have a certain sum of money in 15 years will view a zero coupon bond with a maturity of 15 years as the safest asset. Under the preferred habitat theory he or she would demand a higher expected rate of return on both 10- and 20-year bonds.'

Under the preferred habitat theory he or she would demand a higher expected rate of return on both 10- and 20-year bonds as compensation for risk.

Muijsson, Fishwick and Satchell (2014) do not begin from first principles but instead assume that two sets of investors who exhibit constant absolute risk aversion have preferred habitats – one long and the other short – and choose between portfolios on the basis of the mean and variance of the returns to the portfolios.[221, 222] As Nobel prize-winner Merton (1973) makes clear, however, with uncertainty about bond returns investors who exhibit constant absolute risk aversion will not in general choose between portfolios on the basis of the mean and variance of the returns to the portfolios.[223] Instead these investors will hedge against changes to the investment opportunities that they face – that is, they will hedge against changes to mean bond returns. It is difficult to see, therefore, that one can take seriously the predictions of the model that Muijsson, Fishwick and Satchell propose and that Partington and Satchell employ.[224] The model presumes behaviour on the part of investors that the model's assumptions should preclude.

[217] Modigliani, F and R. Sutch, *Innovations in interest rate policy*, American Economic Review, 1966, pages 178-197.

[218] See also:

Cox, J., J. Ingersoll and S. Ross, *A re-examination of traditional hypotheses about the term structure of interest rates*, Journal of Finance, 1981, pages 769-799.

[219] See, for example:

Modigliani, F and R. Sutch, *Innovations in interest rate policy*, American Economic Review, 1966, page 180-182.

[220] Ingersoll, J., *Theory of financial decision making*, Rowman & Littlefield, 1987, page 401.

[221] Muijsson, C., E. Fishwick and S. Satchell, *Taking the art out of smart beta*, University of Sydney, September 2014, pages 22-24.

[222] An investor who exhibits constant absolute risk aversion will not raise or lower the wealth that he or she exposes to risk as his or her wealth increases. See:

Huang, C-F. and R. H. Litzenberger, *Foundations for financial economics*, North-Holland, 1988, page 21.

[223] Merton R., *An intertemporal capital asset pricing model*, Econometrica, 1973, page 883.

[224] Partington, G. and S. Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, pages 53-55.

A1. Terms of Reference

Expert Terms of Reference

Review of the AER preliminary decision for JEN and the supporting Partington & Satchell report

Jemena Electricity Networks (Vic) Limited
2016-20 Electricity Distribution Price Review

EDPR-5700-0013 **5 January 2016**

1 Background

Jemena Electricity Networks (**JEN**) is an electricity distribution network service provider in Victoria. JEN supplies electricity to approximately 300,000 homes and businesses through its 10,285 kilometres of distribution system. JEN's electricity distribution system services 950 square kilometres of northwest greater Melbourne. JEN's electricity network is maintained by infrastructure management and services company, Jemena Asset Management (**JAM**).

JEN submitted its initial regulatory proposal with supporting information for the consideration of the Australian Energy Regulator (**AER**) on 30 April 2015. This proposal covers the period 2016-2020 (calendar years). The AER published its preliminary determination on 29 October 2015. JEN is currently preparing its submission in response to the preliminary decision, to be submitted to the AER by 6 January 2016.

As with all of its economic regulatory functions and powers, when making the distribution determination to apply to JEN under the National Electricity Rules and National Electricity Law, the AER is required to do so in a manner that will or is likely to contribute to the achievement of the National Electricity Objective, which is:

> *to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:*
>
> *(a) price, quality, safety, reliability and security of supply of electricity; and*
>
> *(b) the reliability, safety and security of the national electricity system.*

The equivalent National Gas Objective is set out in section 23 of the National Gas Law.

Where the AER is making a distribution determination and there are two or more possible decisions that will or are likely to contribute to the achievement of the National Electricity Objective, the AER is required to make the decision that the AER is satisfied will or is likely to contribute to the achievement of the National Electricity Objective to the greatest degree.

The AER must also take into account the revenue and pricing principles in section 7A of the National Electricity Law when exercising its discretion in making those parts of a distribution determination relating to direct control network services. The revenue and pricing principles include the following:

A regulated network service provider should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs in:

(a) providing direct control network services; and

(b) complying with a regulatory obligation or requirement or making a regulatory payment.

The equivalent revenue and pricing principles for gas network regulation are set out in section 24 of the National Gas Law.

Some of the key rules governing the making of a distribution determination are set out below.

Clause 6.4.3(a) of the National Electricity Rules provides that revenue for a regulated service provider is to be calculated adopting a "building block approach". It provides:

The annual revenue requirement for a Distribution Network Service Provider for each regulatory year of a regulatory control period must be determined using a building block approach, under which the building blocks are:

(1) indexation of the regulatory asset base – see paragraph (b)(1);

(2) a return on capital for that year – see paragraph (b)(2);

(3) the depreciation for that year – see paragraph (b)(3);

(4) the estimated cost of corporate income tax of the Distribution Network Service Provider for that year – see paragraph (b)(4);

(5) the revenue increments or decrements (if any) for that year arising from the application of any efficiency benefit sharing scheme, capital expenditure sharing scheme, service target performance incentive scheme, demand management and embedded generation connection incentive scheme or small-scale incentive scheme – see subparagraph (b)(5);

(6) the other revenue increments or decrements (if any) for that year arising from the application of a control mechanism in the previous regulatory control period – see paragraph (b)(6);

(6A) the revenue decrements (if any) for that year arising from the use of assets that provide standard control services to provide certain other services – see subparagraph (b)(6A); and

(7) the forecast operating expenditure for that year – see paragraph (b)(7).

Clause 6.5.2 of the National Electricity Rules, relating to the allowed rate of return, states:

Calculation of return on capital

(a) The return on capital for each regulatory year must be calculated by applying a rate of return for the relevant Distribution Network Service Provider for that regulatory year that is determined in accordance with this clause 6.5.2 (the allowed rate of return) to the value of the regulatory asset base for the relevant distribution system as at the beginning of that regulatory year (as established in accordance with clause 6.5.1 and schedule 6.2).

Allowed rate of return

(b) The allowed rate of return is to be determined such that it achieves the allowed rate of return objective.

(c) The allowed rate of return objective is that the rate of return for a Distribution Network Service Provider is to be commensurate with the efficient financing costs of a benchmark efficient entity

with a similar degree of risk as that which applies to the Distribution Network Service Provider in respect of the provision of standard control services (the allowed rate of return objective).

(d) Subject to paragraph (b), the allowed rate of return for a regulatory year must be:

(1) a weighted average of the return on equity for the regulatory control period in which that regulatory year occurs (as estimated under paragraph (f)) and the return on debt for that regulatory year (as estimated under paragraph (h)); and

(2) determined on a nominal vanilla basis that is consistent with the estimate of the value of imputation credits referred to in clause 6.5.3.

(e) In determining the allowed rate of return, regard must be had to:

(1) relevant estimation methods, financial models, market data and other evidence;

(2) the desirability of using an approach that leads to the consistent application of any estimates of financial parameters that are relevant to the estimates of, and that are common to, the return on equity and the return on debt; and

(3) any interrelationships between estimates of financial parameters that are relevant to the estimates of the return on equity and the return on debt.

Return on equity

(f) The return on equity for a regulatory control period must be estimated such that it contributes to the achievement of the allowed rate of return objective.

(g) In estimating the return on equity under paragraph (f), regard must be had to the prevailing conditions in the market for equity funds.

Return on debt

(h) The return on debt for a regulatory year must be estimated such that it contributes to the achievement of the allowed rate of return objective.

(i) The return on debt may be estimated using a methodology which results in either:

(1) the return on debt for each regulatory year in the regulatory control period being the same; or

(2) the return on debt (and consequently the allowed rate of return) being, or potentially being, different for different regulatory years in the regulatory control period.

(j) Subject to paragraph (h), the methodology adopted to estimate the return on debt may, without limitation, be designed to result in the return on debt reflecting:

(1) the return that would be required by debt investors in a benchmark efficient entity if it raised debt at the time or shortly before the making of the distribution determination for the regulatory control period;

(2) the average return that would have been required by debt investors in a benchmark efficient entity if it raised debt over an historical period prior to the commencement of a regulatory year in the regulatory control period; or

(3) some combination of the returns referred to in subparagraphs (1) and (2).

(k) In estimating the return on debt under paragraph (h), regard must be had to the following factors:

(1) the desirability of minimising any difference between the return on debt and the return on debt of a benchmark efficient entity referred to in the allowed rate of return objective;

(2) the interrelationship between the return on equity and the return on debt;

(3) the incentives that the return on debt may provide in relation to capital expenditure over the regulatory control period, including as to the timing of any capital expenditure; and

(4) any impacts (including in relation to the costs of servicing debt across regulatory control periods) on a benchmark efficient entity referred to in the allowed rate of return objective that could arise as a result of changing the methodology that is used to estimate the return on debt from one regulatory control period to the next.

(l) If the return on debt is to be estimated using a methodology of the type referred to in paragraph (i)(2) then a resulting change to the Distribution Network Service Provider's annual revenue requirement must be effected through the automatic application of a formula that is specified in the distribution determination."

[Subclauses (m)–(q) omitted].

The equivalent National Gas Rules are set out in rule 87.

Clause 6.5.3 of the National Electricity Rules, relating to the estimated cost of corporate income tax, states:

The estimated cost of corporate income tax of a Distribution Network Service Provider for each regulatory year (ETCt) must be estimated in accordance with the following formula:

ETCt = (ETIt × rt) (1 – γ)

where:

ETIt is an estimate of the taxable income for that regulatory year that would be earned by a benchmark efficient entity as a result of the provision of standard control services if such an entity, rather than the Distribution Network Service Provider, operated the business of the Distribution Network Service Provider, such estimate being determined in accordance with the post-tax revenue model;

rt is the expected statutory income tax rate for that regulatory year as determined by the AER; and

γ is the value of imputation credits.

The equivalent National Gas Rule is in rule 87A.

In its initial proposal and submission on the AER issues paper on it, JEN submitted several expert reports from NERA (the **Earlier Reports**) on the appropriate approach to be adopted in estimating the return on equity for the benchmark efficient entity.[225] The AER preliminary decision considered these reports.

[225] 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; NERA, *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; NERA, *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*,

In this context, JEN seeks a report from HoustonKemp, as a suitable qualified independent expert (**Expert**), that reviews and, where appropriate, responds to matters raised in the preliminary decision on the return on equity. JEN seeks this report on behalf of itself, ActewAGL Distribution, Ausnet Services, Australian Gas Networks, Citipower, Powercor, and United Energy.

2 Scope of Work

In its preliminary determination, the AER estimated a return on equity of 7.3% for the benchmark efficient entity (**BEE**) using the Sharpe-Lintner Capital Asset Pricing Model (**SLCAPM**) with a 6.5% market risk premium (**MRP**), a 0.7 equity beta, and a 2.76% risk-free rate. The AER relied on an expert report from Partington and Satchell making its preliminary determination.

The AER defined the BEE as:

> *a pure play, regulated energy network business operating within Australia.*

The Expert will provide an opinion report that:

1. Reviews and critiques the AER preliminary decision and the report from Partington and Satchell, including as to:
   (a) whether there is evidence that the SLCAPM is biased and, if so, what effect the bias has and what, if any, adjustments could be made to offset this bias;
   (b) whether independent experts adjust the SLCAPM for this, or any other, bias and, if so, the nature of any such adjustment;
   (c) whether evidence from independent expert reports should, and, if so how such evidence could, be used to inform the estimate of the return on equity;
   (d) the use made of the paper by Kan, Robotti, and Shanken (2013); and
   (e) any other matter that the Expert considers is relevant to estimating the return on equity arising from the preliminary decision or the Partington and Satchell report.

In preparing the report the Expert will:

A. consider any relevant comments raised by the AER and other regulators, and experts engaged by those regulators;

B. use robust methods and data in producing any statistical estimates; and

C. adopt a sample averaging period of the 20 business days to 30 September 2015 for any prevailing estimates.

March 2015; 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; and NERA, *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.

3 Information to be Considered

The Expert is also expected to consider the following information:

- such information that, in Expert's opinion, should be taken into account to address the questions outlined above;
- relevant literature on estimating the return on equity;
- the AER's Rate of Return Guideline, including explanatory statements and supporting expert material;
- material submitted to the AER as part of its consultation on the Rate of Return Guidelines; and

previous decisions of the AER, other relevant regulators and the Australian Competition Tribunal on the return on equity and any supporting expert material, including the recent final decisions for Jemena Gas Networks and electricity networks in ACT, NSW, Queensland, South Australia and Tasmania.

4 Deliverables

At the completion of its review the Expert will provide an independent expert report which:

- is of a professional standard capable of being submitted to the AER;
- is prepared in accordance with the Federal Court Practice Note on Expert Witnesses in Proceedings in the Federal Court of Australia (CM 7) set out in Attachment 1, and includes an acknowledgement that the Expert has read the guidelines [226];
- contains a section summarising the Expert's experience and qualifications, and attaches the Expert's curriculum vitae (preferably in a schedule or annexure);
- identifies any person and their qualifications, who assists the Expert in preparing the report or in carrying out any research or test for the purposes of the report;
- summarises JEN's instructions and attaches these term of reference;
- includes an executive summary which highlights key aspects of the Expert's work and conclusions; and
- (without limiting the points above) carefully sets out the facts that the Expert has assumed in putting together his or her report, as well as identifying any other assumptions made, and the basis for those assumptions.

The Expert's report will include the findings for each of the five parts defined in the scope of works (Section 2).

5 Timetable

The Expert will deliver the final report to Jemena Regulation by **6 January 2016**.

6 Terms of Engagement

The terms on which the Expert will be engaged to provide the requested advice shall be:

[226] Available at: http://www.federalcourt.gov.au/law-and-practice/practice-documents/practice-notes/cm7.

- as provided in accordance with the Jemena Regulatory Consultancy Services Panel arrangements applicable to the Expert.

A2. 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[227], 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[228]

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[229]

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

[227] 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].

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

[229] 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[230]; 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[231].

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[232].

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

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

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

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

A3. Curriculum Vitae

Simon M. Wheatley

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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

- 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.
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- 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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