27th March 2013

Our Reference: UE.SU.01

Dr Malcolm Roberts
Chairman
Queensland Competition Authority
G.P.O. Box 2257
BRISBANE QUEENSLAND 4001

BY EMAIL TO: research@qca.org.au

Dear Mr Roberts,

Cost of Capital Methodology Review, 2012-13

Please find enclosed a submission prepared by NERA Economic Consulting in response to a discussion paper, released by the Queensland Competition Authority (QCA), on the relationship between the risk-free rate and the market risk premium[1]. The NERA submission refers extensively to a number of reports prepared by Associate Professor Martin Lally, a key adviser to the QCA.

If the QCA has further questions about this submission, then please do not hesitate to contact Jeremy Rothfield, Network Regulation and Compliance Manager, on (03) 8846 9854.
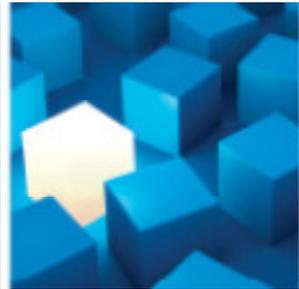

Yours sincerely,

Jeremy Rothfield
Network Regulation and Compliance Manager

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[1] QCA (2012), The Risk-free Rate and the Market Risk Premium, a discussion paper prepared by the Queensland Competition Authority, November 2012.

NERA
ECONOMIC CONSULTING

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

Project Team

Simon Wheatley

Brendan Quach

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Executive Summary

This report has been prepared for Multinet Gas by NERA Economic Consulting (NERA). Multinet Gas has asked NERA to examine a number of issues that arise from recent decisions and reports published by the Australian Energy Regulator (AER), the Queensland Competition Authority (QCA) and advisors to the two regulators.

In particular, Multinet Gas has asked NERA to assess:

1. The theoretical rationale for and empirical evidence on the relation between:

    *   the cost of equity and the equity beta of a firm; and

    *   the market risk premium (*MRP*) and the volatility of the market portfolio,

    and what impact a consistent use of the empirical evidence will have on the value for the cost of equity that one computes;

2. Whether the use of 'Siegel averaging' will produce unbiased estimates of the long-run *MRP*;

3. Whether current market practitioner estimates of the return required on the market are consistent with a constant *MRP* through time when measured against the prevailing yield on 10-year Commonwealth Government Securities (CGS), and whether the estimates are consistent with a prevailing forward looking *MRP* of 6 per cent;

4. To the extent that an historical estimate of the *MRP* is relevant, whether an historical estimate of the *MRP* should be computed using an arithmetic mean, geometric mean, or some weighted average of the two.

5. Whether the dividend growth model (DGM) will necessarily deliver an upwardly biased estimate of the *MRP* for the next regulatory period when the risk-free rate is low.

This report addresses each of these questions in turn.

1. Consistent use of evidence

In its recently published *Access arrangement draft decision, Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013-17* (the AER's *Draft Decision*)), the AER considers two distinct issues relating to the CAPM:

*   whether to use the SL CAPM or Black CAPM to set the cost of equity; and

*   whether to use an intertemporal version of the SL CAPM or other methods to set the *MRP*.

In considering these issues a regulator must decide whether to use a theoretical model, the SL CAPM, in which it may have a strong belief or the evidence that in general rejects the model. A decision that relied solely on a belief in the SL CAPM:

*   would use the SL CAPM to set the cost of equity; and

- would use an intertemporal version of the SL CAPM and an estimate of the volatility of the return to the market portfolio to set the *MRP*. [1]

In contrast, a decision that relied solely on the empirical evidence:

- would conclude that there is no evidence of a link between the cost of equity and the equity beta of a firm and so, if limited to the use of the equity beta of a firm to measure risk, would use the Black CAPM to set the cost of equity;[2, 3] and

- would conclude that there is no evidence of a link between the *MRP* and the volatility of the return to the market portfolio and so would use other methods to set the *MRP*. [4]

Notwithstanding that there is no evidence of a link between the cost of equity and the equity beta of a firm or between the *MRP* and the volatility of the return to the market portfolio, the AER's *Draft Decision* is selective in its reliance on either theory or evidence. Specifically, the AER ignores the evidence against the SL CAPM's ability to predict the returns required on assets and uses the model to set the cost of equity, but rejects the use of an intertemporal version of the SL CAPM to set the *MRP* because of the evidence against the model.

As a result of the selective use of theory and empirical evidence, the AER's *Draft Decision* implicitly asserts that:

- at each point in time an investor will seek an additional return for investing in an asset with a high beta – because of the impact that investing in a high-beta stock will have on the risk of the investor's overall portfolio – that is, the market portfolio; but

- an investor will not seek an additional return for investing in the market portfolio when the risk of the market portfolio is high and will not accept a lower return for investing in the market portfolio when the risk of the market portfolio is low.

To be consistent, the AER must either choose to rely on *all* of the empirical evidence before it or use *none* of the evidence – employing instead its prior belief in the theory underpinning the SL CAPM. Our preference is that when confronted with a divergence between theory and empirical evidence, greater weight should be placed on empirical evidence.

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[1]   Merton (1973) provides conditions under which an intertemporal version of the SL CAPM will hold.

   Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica, 1973, pages 867-887.

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

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

[3]   Grundy (2010) reviews the empirical evidence on the SL CAPM and states:

   'I know of no published study that has empirically tested the Sharpe CAPM and failed to reject the Sharpe CAPM.'

   Grundy, B., *The calculation of the cost of capital: A report for Envestra*, University of Melbourne, 30 September 2010, page 10.

[4]   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

2. Siegel Averaging

Lally (2012) argues, on the basis of evidence that Siegel (1992) provides, that the sample mean of a series of returns to the market portfolio in excess of the yield on a government bond can be an upwardly biased estimate of the long-run *MRP*. [5] Lally's argument is based on a view that:

- investors have systematically underestimated inflation; and that

- while the real returns to stocks are, in the long run, protected against unanticipated inflation, the real returns to bonds are not protected against unanticipated inflation.

Lally argues that while investors have in the past underestimated inflation, they will not do so in the future. As a result, he argues that:

- while the real return to the market portfolio in the future will on average be similar to its real return in the past;

- the real return to a government bond in the future will on average be higher than it has been in the past.

So Lally argues that an unbiased estimate of the long-run *MRP* going forward will be lower than the sample mean, computed from past data, of a series of returns to the market portfolio in excess of a government bond yield.

We show here that Lally's argument makes little sense because the available evidence does not support the idea that those whose business it is to forecast inflation – that is, professional forecasters – systematically underestimate inflation. We identify periods over which forecasters have underestimated inflation but these are matched by periods over which forecasters have overestimated inflation. So it is difficult to see how the sample mean of a series of returns to the market portfolio in excess of the yield on a government bond can be viewed as an upwardly biased estimate of the long-run *MRP*.

The QCA (2012) uses Lally's suggestion and computes and estimate of the long-run *MRP* for Australia of 4.32 per cent per annum. [6] The QCA arrives at this figure by subtracting the difference between what it deems to be the long-run real yield, 4 per cent, and the average real holding-period return from 1900 to 2000 of 1.9 per cent that Dimson, Marsh and Staunton (2002) report from an estimate of the with-imputation-credit *MRP* taken from Brailsford, Handley and Maheswaran (2012) of 6.21 per cent per annum. [7] Clearly, the QCA has made an arithmetical error and has instead subtracted the long-run real yield of 1.9 per cent from the with-imputation-credit *MRP* of 6.21 per cent per annum. Regardless of how

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[5]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 28-29.

[6]   QCA, The risk-free rate and the market risk premium, November 2012, page 11.

[7]   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.

Dimson, E., P. Marsh, and M. Staunton, *Triumph of the Optimists*, Princeton University Press: Princeton, New Jersey, United States, 2002.

the QCA arrived at the figure, however, the QCA assumes that investors have underestimated inflation by around two per cent each year over the 128-year period from 1883 to 2010. The evidence that we provide suggests that this assumption is not credible.

3. Market practitioner estimates

Independent expert reports potentially provide an alternative source of information on the value for the *MRP* used by market participants. The use of independent expert reports circumvents a number of the problems associated with other forms of market data such as 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 how returns are measured, that is, whether returns are continuously compounded or not continuously compounded;

- 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.

We examine 132 independent expert reports conducted between 2008 and 2012 and find evidence of a significant negative relation between the 10-year CGS yield and the *MRP* that experts choose relative to the yield. From this relation we estimate that the *MRP* relative to the CGS yield for 21 February 2013 of 3.55 per cent per annum should lie between 7.11 and 7.53 per cent per annum inclusive of a value assigned to imputation credits. Separately we estimate that the *MRP* relative to the 10-year CGS yield computed from the 17 independent expert reports published in 2012 lies between 7.32 and 8.00 per cent per annum, inclusive of a value assigned to imputation credits.

Further, statistical tests that we conduct show that an *MRP* of 6 per cent is inconsistent with the *MRP* (relative to the 10-year CGS yield over 2012) contained in the 17 independent expert reports published in 2012.

4. Estimating the historical *MRP*

In the *Draft Decision* the AER states its belief that consideration should be given to estimates of the *MRP* based on both arithmetic and geometric averages. Whether an arithmetic or geometric average is appropriate will depend on whether there is any compounding of estimates of the *MRP* in the regulatory process.

- In the absence of compounding an arithmetic average should be used since the use of a geometric average will produce a downwardly biased estimate of the *WACC*.

- On the other hand, if regulatory returns are compounded, then some weight should be placed on a geometric average since an arithmetic average used alone will produce an upwardly biased estimate of the *WACC*.

We show that, aside from some minor adjustments to the regulatory asset base (*RAB*) and to the evolution of prices over the regulatory period, the AER *never* compounds the *WACC* over more than one year. As a result, the use of an arithmetic average will produce an *unbiased* estimate of the revenue that the market requires in any one year on the *RAB*. In contrast, an estimate of the *WACC* that is in part based on a geometric average of the *MRP* will produce a *downwardly biased* estimate of the revenue that the market requires in any one year.

5. The *DGM*

A natural place to look for information on what the market thinks the *MRP* should be is in market prices. The DGM allows one, in principle, to use market prices together with forecasts of future dividends to be distributed by the market portfolio to compute the return that the market requires on the portfolio. The return that the DGM delivers, though, is the single internal rate of return that will discount back the market's expectations of the dividends that the market portfolio will pay in all future periods – not just over the next regulatory period – back to the current market value of the market portfolio. This internal rate of return will be a complicated average of the expected returns to the market portfolio over the next year and over all future years.

As we point out in our March 2012 report and as Lally points out in his July 2012 and March 2013 reports, the internal rate of return that the DGM delivers may lie above or below the current expected return to the market. [8] Nevertheless, we show that there are recently encountered circumstances where it would have been difficult to argue persuasively that the expected return over the next regulatory period sat below the return delivered by the DGM. In the particular circumstances, the risk-free rate was low relative to its history but, contrary to the arguments put forward by Lally, it would have been difficult to argue that the expected return to the market portfolio over the next regulatory period sat below the return delivered by the DGM.

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[8]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, page 3.

 Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013, pages 5-9.

 NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 42.

1.   Introduction

This report has been prepared for Multinet Gas by NERA Economic Consulting (NERA). Multinet Gas has asked NERA to examine a number of issues that arise from recent decisions and reports published by the Australian Energy Regulator (AER), the Queensland Competition Authority (QCA) and advisors to the two regulators.

In particular, Multinet Gas has asked NERA to assess:

- the evidence that exists on the relation between mean return and beta across assets and on the relation between the mean return to the market portfolio and the volatility of the market portfolio over time, and what impact a consistent use of the evidence will have on the value for the cost of equity that one computes;

- whether the use of 'Siegel averaging' will produce unbiased estimates of the long-run *MRP*;

- what value for the *MRP* relative to the current yield on a 10-year Commonwealth Government Security (CGS) market practitioners are currently using;

- whether an estimate of the long-run *MRP* computed using historical data should be based on the arithmetic mean of a sample of returns to the market portfolio, on the geometric mean or on some weighted average of the two means; and

- whether the dividend growth model (DGM) will necessarily deliver an upwardly biased estimate of the *MRP* for the next regulatory period when the risk-free rate is low.

The remainder of this report is structured as follows:

- section 2 considers how to interpret the evidence on the relation between mean returns and betas across assets and on the relation between the mean return to the market portfolio and the volatility of the market portfolio over time;

- section 3 examines the use of Siegel averaging to produce an estimate of the long-run *MRP*;

- section 4 examines what value for the *MRP* relative to the current 10-year CGS yield market practitioners are currently using;

- section 5 examines the arguments for using arithmetic means and against using geometric means;

- section 6 examines the use of the DGM; and

- section 7 provides conclusions.

In addition, Appendix A examines other miscellaneous issues while Appendix B provides the curricula vitae for the two project members.

1.1. Statement of Credentials

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

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

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

In preparing this report, each of the joint authors (herein after referred to as 'we' or 'our' or 'us') confirms that we have made all the inquiries we believe are desirable and appropriate to answer the questions put to us and no matters of significance that we regard as relevant have, to our knowledge, been withheld from this report. We have been provided with a copy of the Federal Court guidelines *Federal Court of Australia, Practice Note CM 7, Expert Witnesses in Proceedings in the Federal Court of Australia* dated 1 August 2011. We have reviewed those guidelines and this report has been prepared consistently with the form of expert evidence required by those guidelines.

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

2.   The CAPM

In this section we assess the evidence that exists on the relation between mean return and beta across assets and on the relation between the mean return to the market portfolio and the volatility of the market portfolio over time. We also assess what impact a consistent use of the evidence will have on the value for the cost of equity that one computes.

2.1.   Consistent Use of the Evidence

We note in our March 2012 report to the AER that the evidence provided by CEG (2008) and Lajbcygier and Wheatley (2012) indicates that there is no relation in Australian data between the mean return to a stock and its beta.[9] Figure 2.1 below, drawn from CEG's report, illustrates this empirical regularity. The figure plots the mean returns to 10 value-weighted portfolios, formed on the basis of past estimates of beta, against their betas using data from 1974 to 2007. Figure 2.1 shows that there is a substantial variation in beta across portfolios but no relation between the mean return to a portfolio and its beta.   This evidence is not consistent with the Sharpe-Lintner (SL) Capital Asset Pricing Model (CAPM) which predicts that there should be a positive relation between mean return and beta.[10]

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

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

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

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

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

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

[10]   Roll (1977) emphasises that the SL CAPM predicts that the market portfolio of all assets must be mean-variance efficient. He also emphasises that tests of the SL CAPM that use a proxy for the market portfolio can reject the model, even when the model is true, because the proxy is poor. The issue that concerns Roll is whether evidence based on proxies for the market portfolio can be used to infer whether the SL CAPM itself is true or false. Discovering whether the model itself is really true, though, is not an issue that concerns us. The issue that concerns us is whether the empirical version of the SL CAPM that the AER uses produces accurate estimates of required returns. The empirical version of the SL CAPM that the AER uses employs a value-weighted portfolio of Australian stocks as a proxy for the market portfolio of all assets. In what follows, all references to the empirical evidence on the SL CAPM are to the empirical version of the model that the AER uses – unless we specify otherwise.

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

measures the risk of an individual asset. Assets that have higher betas must, in the SL CAPM, have higher mean returns.

In an intertemporal version of the SL CAPM there will also be a positive relation, through time, between the *MRP* and the variance of the return to the market portfolio. [11] Thus in an intertemporal version of the SL CAPM an investor will seek compensation for bearing additional risk at each point in time and will also seek compensation for bearing additional risk through time. In other words, at each point in time an investor will seek an additional return for investing in an asset with a high beta – because of the impact that investing in a high-beta stock will have on the risk of the investor's overall portfolio – that is, the market portfolio. Also, through time, an investor will seek an additional return for investing in the market portfolio when the risk of the market portfolio is high and will accept a lower return for investing in the market portfolio when the risk of the market portfolio is low.

Figure 2.1
Mean return against beta for 10 portfolios sorted on beta
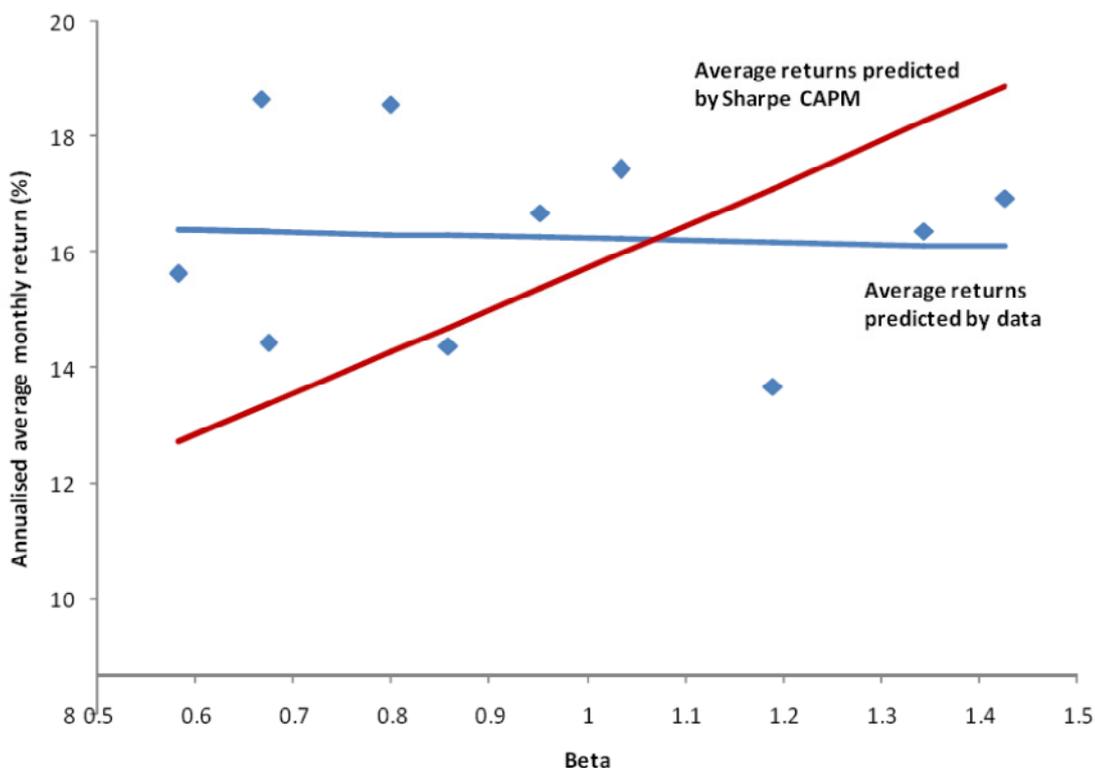
Source: CEG, Estimation of, and correction for, biases inherent in the Sharpe CAPM formula: A report for the Energy Networks Association Grid Australia and APIA, September 2008, Figure 2.

In our March 2012 report we estimate the current *MRP* using an intertemporal version of the SL CAPM, a regime-switching model and the data that Brailsford, Handley and Maheswaran

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[11]   Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica, 1973, pages 867-887.

(2012) provide and that we update. [12] Since the risk of the market portfolio appears to have been far lower in the first 75 years or so of these data than currently, the use of an intertemporal version of the SL CAPM provides a higher estimate of the current *MRP* than simply averaging the past returns to the market portfolio in excess of the risk-free rate.

McKenzie and Partington (2012), however, provide evidence against an intertemporal version of the SL CAPM. [13] They show that the mean excess return to the market portfolio is lower, albeit insignificantly so, when market volatility is high than when market volatility is low. Figure 2.2 illustrates their results. The figure plots their estimates of the mean excess return to the market portfolio from Table 2 of their report against their estimates of the variance of the excess returns taken from the same table. The figure also plots their estimate of the relation that would hold between the mean excess return to the market portfolio and the variance of the excess return to the portfolio were the intertemporal version of the SL CAPM to be true, taken from their Table 4.

Thus CEG (2008) and Lajbcygier and Wheatley (2012) show that there is evidence against the predictions of the SL CAPM for the cross section of mean returns to stocks while McKenzie and Partington (2012) show that there is evidence against the predictions of an intertemporal version of the SL CAPM on the *MRP*. [14] CEG and Lajbcygier and Wheatley show that there is no relation between mean return and beta across stocks while McKenzie and Partington show that there is no relation between the *MRP* and the risk of the market portfolio through time.

Consistency, we believe, requires the AER to follow one of two paths. The first path is to set a cost of equity based on the empirical evidence that Figures 2.1 and 2.2 summarise, that is:

- set the cost of equity equal to the return required on the market portfolio or equivalently set beta to one; and

- ignore the link that an intertemporal version of the SL CAPM implies should exist between the *MRP* and the volatility of the market portfolio.

The second path is to ignore the empirical evidence that Figures 2.1 and 2.2 summarise and:

- use the SL CAPM to set the cost of equity; and

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[12]   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.

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

[13]   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

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

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

McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

- use the link that an intertemporal version of the SL CAPM implies should exist between the *MRP* and the volatility of the market portfolio to estimate the *MRP*.

Figure 2.2
Mean excess return against variance of excess return for the market portfolio
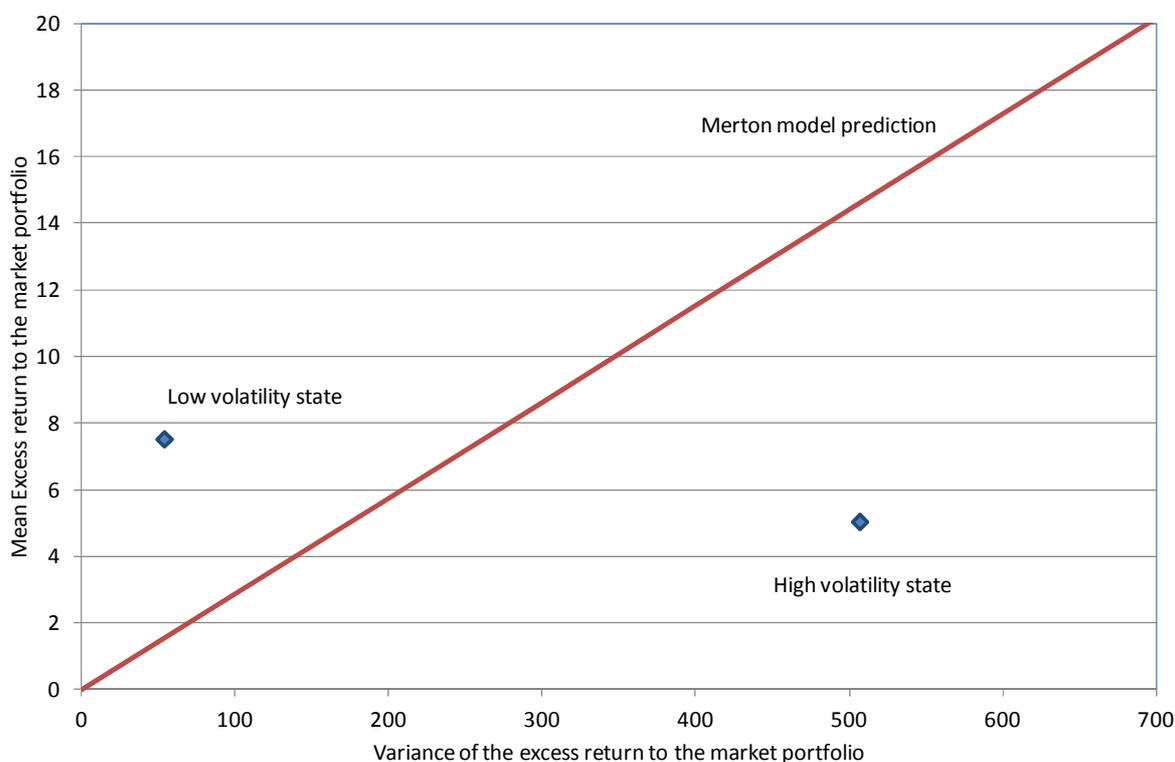
Source: McKenzie, M. and G. Partington, Review of regime switching framework and critique of survey evidence, SIRCA Limited, 7 September 2012.

We do not have prior beliefs about whether the SL CAPM is true and so our preference is to use the empirical evidence that CEG (2008), Lajbcygier and Wheatley (2012) and McKenzie and Partington (2012) provide and follow the first path. [15] The AER has in the past indicated that it has a strong prior belief that the SL CAPM is true. [16] If that is the case, then the AER may wish to ignore the evidence that CEG, Lajbcygier and Wheatley and McKenzie and Partington provide and follow the second path.

To be consistent, though, the AER must either use all of the evidence before it or use none of it – employing instead its prior beliefs. It can make no sense to argue that:

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

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

   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

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

- at each point in time an investor will seek an additional return for investing in an asset with a high beta – because of the impact that investing in a high-beta stock will have on the risk of the investor's overall portfolio – that is, the market portfolio; but

- an investor will not seek an additional return for investing in the market portfolio when the risk of the market portfolio is high and will not accept a lower return for investing in the market portfolio when the risk of the market portfolio is low.

Again, beta measures the contribution of an asset to the risk of the market portfolio, measured by standard deviation of return. So it is difficult to see how one can simultaneously argue that:

- beta is the only measure of the risk of an individual asset about which investors care; but

- investors do not care about the risk of the market portfolio, measured by the standard deviation of the return to the portfolio.

By using the SL CAPM to set the cost of equity, the AER is assuming that investors care about the risk of the market portfolio.

It is an error for the AER to use only some of the evidence before it on the SL CAPM. It is an error, for example, for the AER to:

- ignore the evidence against the restrictions that the SL CAPM imposes on the cross-section of mean returns; but

- use the evidence against the restrictions that an intertemporal version of the SL CAPM imposes on the behaviour of the *MRP* through time.

Put another way, it is an error for the AER to use only some of the theoretical restrictions imposed by the SL CAPM. It is an error, for example, for the AER to:

- use the SL CAPM to compute a cost of equity; but

- ignore the restrictions that an intertemporal version of the SL CAPM imposes on the behaviour of the *MRP* through time in computing an *MRP*.

2.2. The Cross-Section of Mean Returns

The central question that should be answered when determining how to compute a cost of equity for a company that the AER regulates can be set out in the following way. If one is limited to using beta as a measure of the risk of equity, then:

- should one determine the cost of equity using the blue line in Figure 2.1 – the line that best fits the scatter plot of blue diamonds; or

- should one ignore the empirical evidence and choose the cost of equity using the red line – the theoretical prediction that the SL CAPM would make if the market portfolio of stocks and the market portfolio of all assets were one and the same?

Common sense would dictate that one would use the blue line and not the red line to compute the cost of equity.

McKenzie and Partington (2012) make a number of arguments to suggest that one should not take this common sense approach and that one should instead set aside the evidence that CEG (2008) and Lajbcygier and Wheatley (2012) provide. [17]

The first argument that McKenzie and Partington make is that the results that CEG and Lajbcygier and Wheatley provide are not plausible because they imply that: [18]

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

This argument is not correct. The evidence that CEG and Lajbcygier and Wheatley provide indicates solely that beta is not useful for explaining the cross-section of mean returns – a result against which Figure 2.1 suggests it should be difficult to argue. This evidence does not imply that the return required on a stock is a constant both across stocks and through time. The return to a stock may depend on sources of risk other than an exposure to the return to the market portfolio.

The evidence that CEG (2008) and Lajbcygier and Wheatley (2012) provide does imply that if one is constrained to choose between the SL CAPM and Black CAPM, one would choose to use the Black CAPM and set the return required on each stock to be a constant or, equivalently, set the beta on every stock to equal one. [19] This crude outcome would not arise were it permissible to consider measures of risk other than beta alone. The AER, though, has stated on several occasions that it will not consider other measures of risk. For example, in June 2010 the regulator stated that: [20]

'the AER does not approve the revised access arrangement proposal to use the (Fama-French three-factor model) for estimating the cost of equity.'

McKenzie and Partington (2012) also point out that estimates of the zero-beta rate can, in principle, be sensitive to the choice of a proxy for the market portfolio. [21] In particular, they

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

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

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

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

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

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

[20]   AER, Jemena Gas Networks Access arrangement proposal for the NSW gas networks 1 July 2010 – 30 June 2015, June 2010, page 172.

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

illustrate this potential problem with numerical examples. The examples are based on a world in which there are three assets whose characteristics are described in Table 2.1.

Table 2.1
Numerical example from McKenzie and Partington (2012)

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

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

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

McKenzie and Partington (2012) first consider two efficient portfolios whose characteristics are described in Table 2.2 and that appear in Figure 2.3, which plots mean return against standard deviation of return. [22] Figure 2.3 also plots those portfolios that have minimum variance of return for a given mean return; these portfolios plot along the hyperbola in the figure. [23] It is evident from Figure 2.3 that portfolios 1 and 2 plot close to the global minimum-variance portfolio constructed from the three assets. The global minimum-variance portfolio is the portfolio that has least risk, measured by standard deviation of return, irrespective of mean return, among all portfolios constructed solely from risky assets.

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

[23]   The identity of each minimum-variance portfolio can be found by minimising

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

subject to the constraints

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

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

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

Table 2.2
Characteristics of efficient portfolios 1 and 2

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

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

Figure 2.3
Numerical example from McKenzie and Partington (2012)
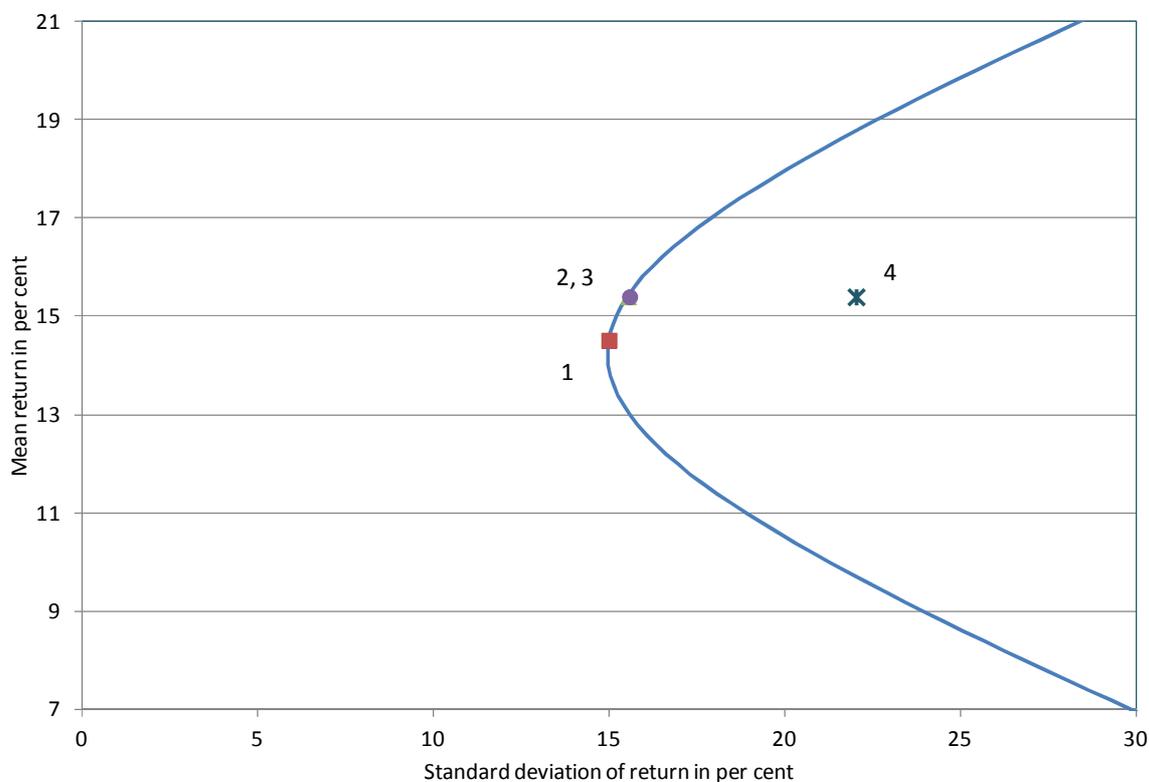
Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Tables 2 and 3.

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

Figure 2.4 plots mean return against beta computed relative to portfolios 1 and 2 for the three assets A, B and C. The zero-beta rate will be the point where a line drawn through the three assets crosses the mean return axis. Thus the example that McKenzie and Partington (2012) provide shows that if the market portfolio were an efficient portfolio and were to plot close to the global minimum-variance portfolio, then estimates of the zero-beta rate would be sensitive to a small change in the composition of the market portfolio.[24] The zero-beta rate associated with portfolio 1 is -50.04 per cent per annum while the zero-beta rate associated with portfolio 2 is -0.85 per cent per annum. The very large and negative zero-beta rate associated with portfolio 1 reflects its proximity to the global minimum-variance portfolio.

Figure 2.4
Plot of mean return against betas computed relative to portfolios 1 and 2
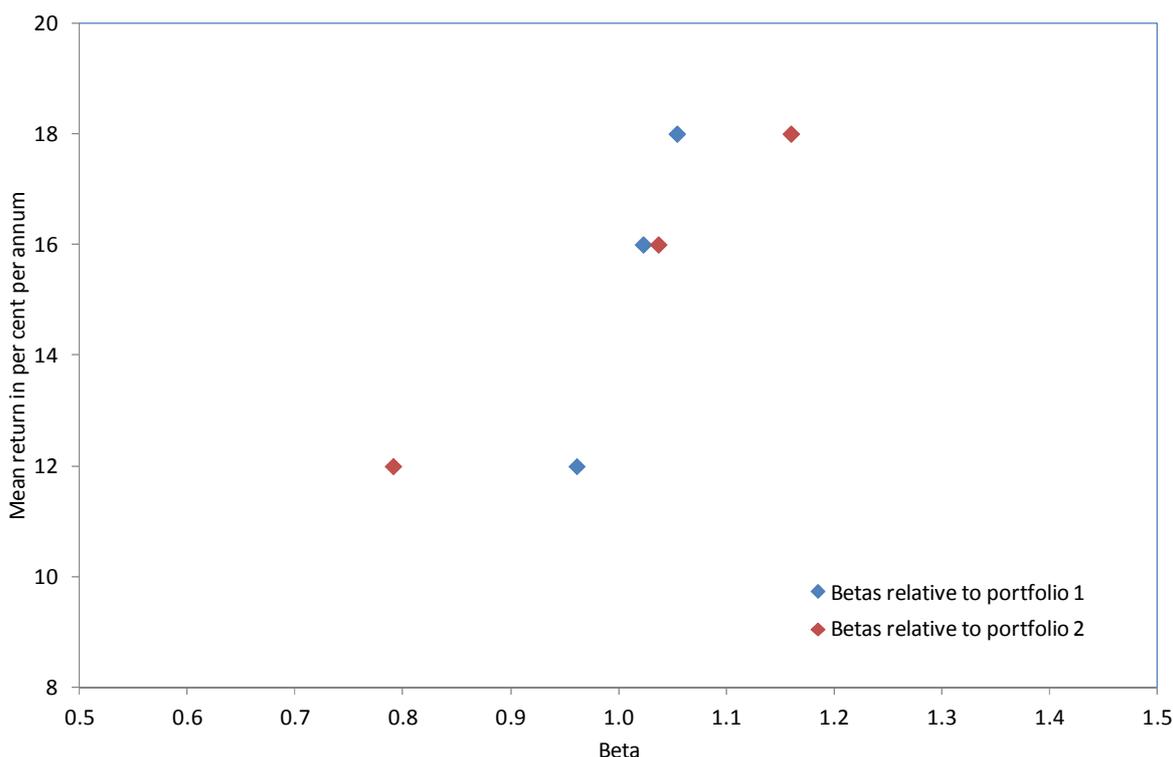
Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA Limited, 24 August 2012, Table 2.

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

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

down the opportunity of an extra mean return of 4.26 basis points for each additional basis point of risk, measured by standard deviation of return, taken on (4.26 is the slope of the hyperbola in Figure 2.3 at the point where portfolio 1 plots). An investor holding portfolio 2 would be turning down the opportunity of an extra mean return of 1.05 basis points for each additional basis point of risk taken on (1.05 is the slope of the hyperbola at the point where portfolio 1 plots). These rewards far exceed anything that is available in the market. [25]

A comparison of Figure 2.1, which uses actual data, with Figure 2.4, which uses the hypothetical data that McKenzie and Partington (2012) provide and the same axes that Figure 2.1 employs, indicates that, in practice, there is a far wider dispersion in beta than in McKenzie and Partington's hypothetical data. [26] This suggests that, in practice, the market portfolio does not plot close to the global minimum-variance portfolio. This suggestion is correct as Figure 2.5 illustrates. Figure 2.5 plots the annualised sample mean excess returns to sample minimum-variance portfolios and the market portfolio against the annualised sample standard deviations of their returns using monthly Australian data from 1974 to 2010.

Figure 2.5 indicates that not only does the market portfolio not plot close to the global minimum-variance portfolio but that – at least for the sample that consists of the largest 500 stocks listed on the Australian Stock Exchange (ASX) that Lajbcygier and Wheatley (2012) use – the global minimum-variance portfolio's Sharpe ratio exceeds the market portfolio's Sharpe ratio. [27] A portfolio's Sharpe ratio, a measure of the portfolio's performance, is the ratio of the mean return to the portfolio in excess of the risk-free rate to the standard deviation of the return to the portfolio. The Sharpe ratio of the global minimum-variance portfolio in Figure 2.5 is 0.59 while the Sharpe ratio of the market portfolio is 0.22.

A similar empirical regularity exists in US data. Jagannathan and Ma (2003) and Clarke, de Silva and Thorley (2006, 2011), for example, provide evidence that in US data the minimum-variance portfolio constructed from widely traded equities has a Sharpe ratio that exceeds the Sharpe ratio of the market portfolio. [28] The difference between the composition and performance of a minimum variance index and the composition and performance of the market portfolio has led Morgan Stanley to produce a number of minimum variance indices. [29]

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

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

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

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

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

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

[29] http://www.msci.com/products/indices/strategy/risk_premia/minimum_volatility/

Figure 2.5
Empirical evidence on the characteristics of the market portfolio
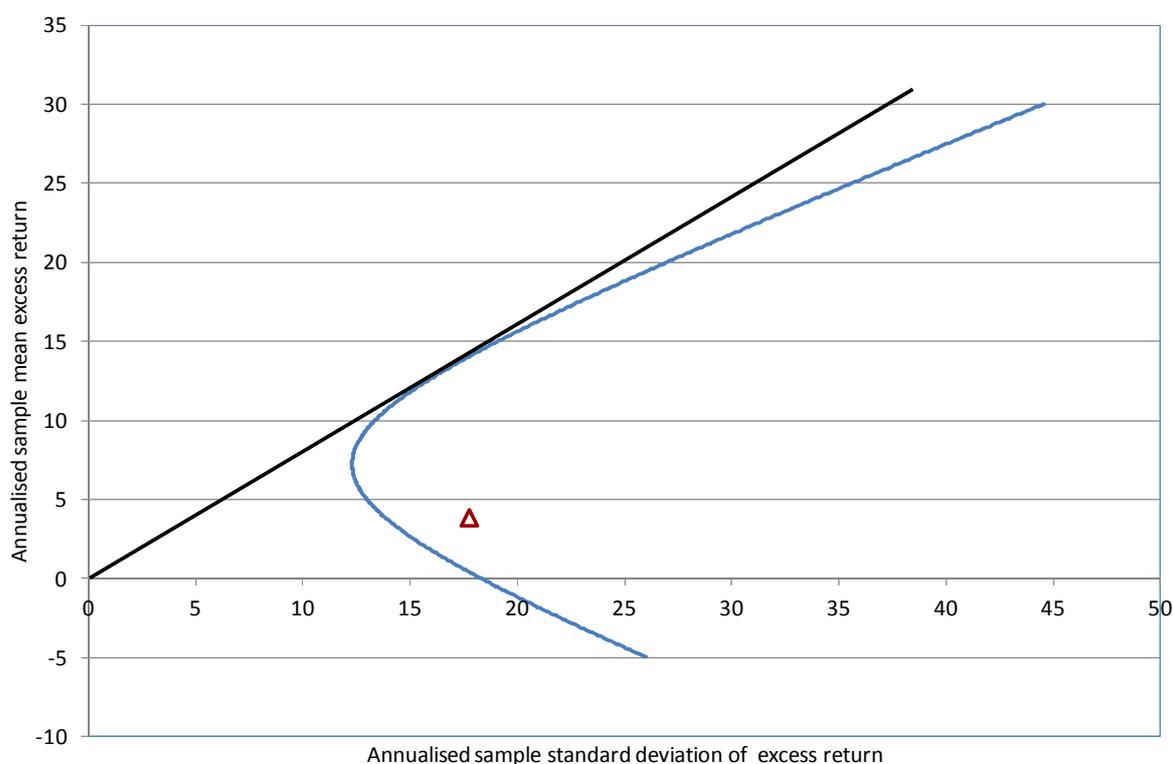
Source: Lajbcygier, P. and S. M. Wheatley, An evaluation of some alternative models for pricing Australian stocks, Monash University, March 2012.

Note: Data are from 1974 to 2010 and are from the Reserve Bank of Australia and from the Share Price and Price Relative Database originally constructed by the Australian Graduate School of Management. The hyperbola is the sample minimum variance set constructed from 10 portfolios formed on the basis of past estimates of beta. The triangle is the market portfolio.

We conclude that the example that McKenzie and Partington (2012) provide to demonstrate that estimates of the zero-beta rate can, in principle, be sensitive to the choice of an efficient proxy for the market portfolio are of no practical relevance. [30] There is a body of evidence that indicates that the market portfolio plots far from the neighbourhood in mean-variance space where the issue that McKenzie and Partington raise would prove to be a problem. The potential problem that McKenzie and Partington identify would only arise if there were little variation across equities in their betas. Empirically, it is known that this is not the case.

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

McKenzie and Partington (2012) next consider two inefficient portfolios whose characteristics are described in Table 2.3 and that also appear in Figure 2.3. [31] It is evident

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

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

from Figure 2.3 that portfolio 3 is close to being an efficient portfolio while portfolio 4 is far from being an efficient portfolio.

It is also evident from Table 2.3 that the composition of portfolios 3 and 4 differ substantially. For example, the weight of security A in portfolio 3 is 50 per cent but in portfolio 4 it is just 10 per cent. As another example, the weight of security C in portfolio 3 is just 10 per cent but in portfolio 4 it is 70 per cent. Not surprisingly, the beta of each security is sensitive to whether the beta is computed relative to portfolio 3 or portfolio 4. As a result, an estimate of the zero-beta rate found by drawing a line that best fits the three points in Figure 2.6, corresponding to the three securities, will depend upon what portfolio is chosen.

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

Table 2.3
Characteristics of portfolios 3 and 4

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

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

A comparison of Tables 2.2 and 2.3 shows that portfolios 2 and 3 share a similar composition, have identical mean returns and have risks, measured by standard deviation of return, that barely differ from one another. Consequently, the betas of the three individual securities should not be sensitive to the choice of portfolio 2 or 3 as an index and, in addition, an estimate of the zero-beta should not be sensitive to the choice of portfolio 2 or 3 as an index. Surprisingly, however, McKenzie and Partington (2012) state that:

> 'Despite this close similarity between the two portfolios, the relation between beta and return is very different as is evident from comparing Figure 2 and Figure 3.

It is clear that in moving from Figure 2 to Figure 3 that the intercept has switched
from being negative fifty percent to a positive value.'

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

Figure 2.6
Plot of mean return against betas computed relative to portfolios 3 and 4
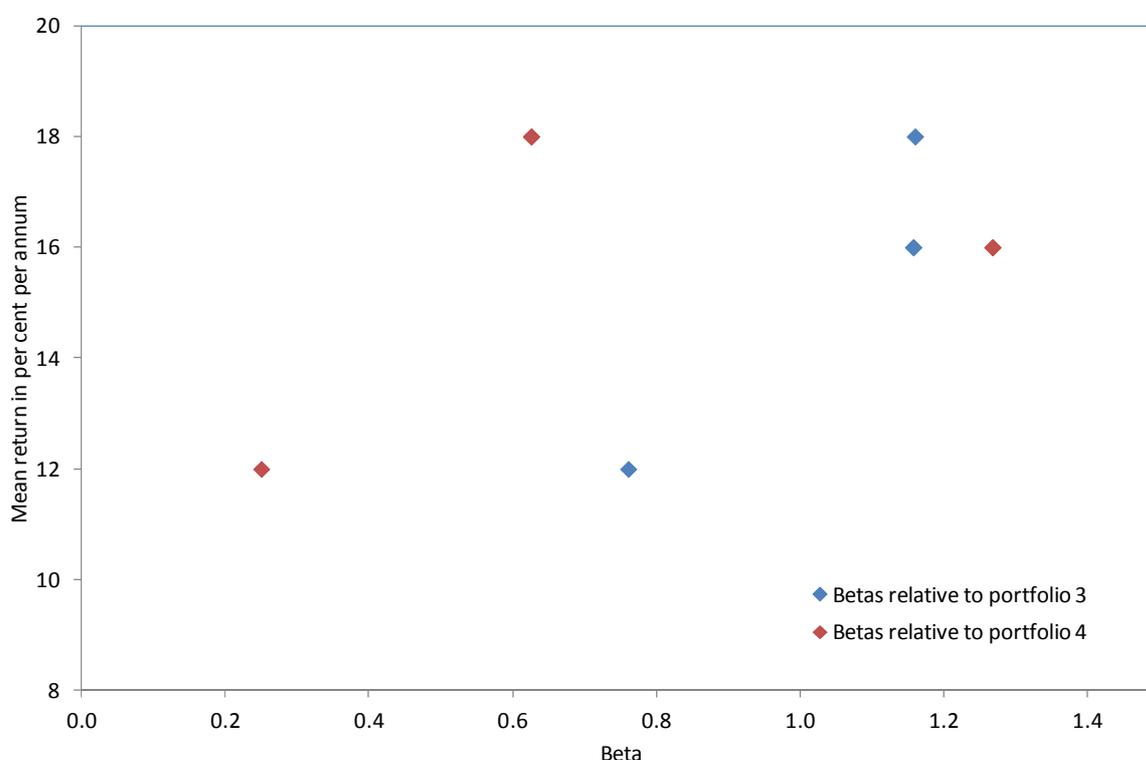
*Source: McKenzie, M. and G. Partington, Review of NERA report on the Black CAPM, SIRCA
Limited, 24 August 2012, Table 3.*

2.2.3. Uniqueness of the zero-beta rate

If the portfolio relative to which betas are computed is a minimum-variance portfolio, but not
the global minimum-variance portfolio, then there will be a unique zero-beta rate associated
with the portfolio. If the portfolio relative to which betas are computed is not a minimum-

variance portfolio, then, as McKenzie and Partington (2012) correctly point out, there will not be a unique zero-beta rate associated with the portfolio. [32]

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

In practice, the use of generalised instead of ordinary least squares or the use of different sets of data can provide different estimates. How different, though, is an empirical matter. In our March 2012 report we report estimates that both CEG (2008) and Lajbcygier and Wheatley (2012) provide. [33] CEG use portfolios formed on the basis of past estimates of beta, ordinary least squares and data from 1974 to 2007. Lajbcygier and Wheatley use individual securities, the generalised least squares method of Litzenberger and Ramaswamy (1979) and Shanken (1992) and data from 1963 to 2010. [34] Despite the choice of a different set of assets, different regression methods and the use of different time series, the estimates that CEG and Lajbcygier and Wheatley report do not differ dramatically. The four sets of estimates of the mean return to a zero-beta portfolio in excess of the risk-free rate that we report in Table 3.1 of our March 2012 report range from 6.99 to 10.31 per cent per annum and all differ significantly from zero at conventional levels.

We conclude that, in practice, the issue that McKenzie and Partington (2012) raise about the non-uniqueness of the zero-beta rate attached to an inefficient portfolio is of little concern. [35] The primary aim is to determine using the equity beta of a regulated utility what is its cost of equity. Regression is well suited to this task and produces, while not a unique set of estimates, a limited range of estimates.

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

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

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

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

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

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

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

2.2.4. Thin trading

McKenzie and Partington (2012) state that thin trading:[36]

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

Although this statement is correct, thin trading will not be an issue for tests that use monthly data and either value-weighted portfolios or large firms. Most large firms trade not just close to the end of every month but either close to or at the end of every day. Figure 2.1 uses value-weighted portfolios of stocks and monthly data and so it is inconceivable that thin trading will have had an impact on the appearance of the graph.

2.2.5. Standard errors

McKenzie and Partington (2012) suggest that the standard errors attached to the estimates of the zero-beta return in excess of the risk-free rate that we report in our March 2012 may be misleading. [37] In particular, they state that:[38]

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

We note in our March 2012 report that: [39]

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

Shanken and Zhou (2007) provide simulation support for the argument that the extent to which the standard errors overstate the precision is likely to be small. [40] They examine the behaviour of estimates of the zero-beta return in excess of the risk-free rate computed using the procedures of Fama and MacBeth (1973) and Litzenberger and Ramaswamy (1979). [41]

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

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

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

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

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

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

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

Shanken and Zhou report no evidence that would suggest that the inference that we draw from the results of CEG (2008) and Lajbcygier and Wheatley (2012) should be revised in any meaningful way. [42] For example, using simulations in which the returns that they generate are normally, identically and independently distributed through time, Shanken and Zhou find that a *t*-test based on an ordinary (weighted) least squares estimate of the zero-beta excess return constructed using 30 years of data rejects the null that the return is zero 5.95 (5.47) per cent of the time at the 5 per cent level when the data are constructed to satisfy the null that the zero-beta excess return is zero. [43] CEG and Lajbcygier and Wheatley use over 30 years of data.

Shanken and Zhou (2007) also examine the impact of relaxing the assumption that returns are normally distributed through time. [44] In particular, they assume that returns follow a multivariate *t*-distribution and so they allow for fat tails and conditional heteroscedasticity. They find that: [45]

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

Although Shanken and Zhou refer here to tests of hypotheses about the *MRP*, it is reasonable to assume that they would not be so perverse as to hide evidence that introducing heterscedasticity had an important impact on tests about the zero-beta excess return.

McKenzie and Partington (2012) also refer to the work of Beaulieu, Dufour, Khalaf (2012) who examine the multivariate regression framework that is an alternative to the Fama and MacBeth (1973) two-pass regression approach. [46] The results that we discuss in our March

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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.

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

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

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

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

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

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

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

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

2012 report do not use this alternative method.[47] McKenzie and Partington conclude that Beaulieu, Dufour, Khalaf show that:[48]

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

This is the wrong conclusion to draw from the work of Beaulieu, Dufour, Khalaf. Beaulieu, Dufour, Khalaf show that when simulations are calibrated to actual data, a *t*-test based on an ordinary least squares estimate of the zero-beta excess return constructed using 10 (69) years of data rejects the null that the return is zero 9.60 (5.00) per cent of the time at the 5 per cent level when the null is true.[49] CEG (2008) and Lajbcygier and Wheatley (2012) use over 30 years of data and so the results that Beaulieu, Dufour, Khalaf report do not suggest that the inference that we draw from the results of CEG and Lajbcygier and Wheatley should be revised in any significant way.[50]

2.2.6. Summary

The simple message conveyed by Figure 2.1, provided by CEG (2008), is that an estimate of the equity beta of a firm is not useful for determining the firm's cost of equity.[51] McKenzie and Partington (2012) argue, on the other hand, that:[52]

- estimates of the zero-beta excess return can, in principle, be unstable;

- thin trading can create the impression that beta cannot explain the cross-section of mean returns; and

- the standard errors attached to estimates of the zero-beta excess return are unreliable.

We show here that:

- the concerns that McKenzie and Partington raise about the stability of the zero-beta excess return will not, in practice, arise;

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

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

[49]   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

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

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

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

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

- the results of CEG (2008) and Lajbcygier and Wheatley (2012) are largely based on the behaviour of the returns to large firms and large firms are not thinly traded; [53] and

- published simulation evidence indicates that the standard errors attached to estimates of the zero-beta excess return are not unreliable.

In our March 2012 report, we also note that: [54]

- as a practical matter, there is a strong and significant positive relation between past estimates of the zero-beta excess return and future estimates of the zero-beta excess return – in other words, past estimates of the zero-beta excess return can *predict* future estimates of the zero-beta excess return.

2.3. Time Series Variation in Volatility

McKenzie and Partington (2012) provide evidence against an intertemporal version of the SL CAPM. [55] They show in Table 2 of their paper that the mean excess return to the market portfolio is lower, albeit insignificantly so, when market volatility is high than when market volatility is low. We do not dispute these results. While there is evidence of a positive relation between the mean excess return to the market portfolio and market volatility in US data, McKenzie and Partington show that evidence of a similar relation in Australian data appears to be absent. [56] The results of McKenzie and Partington, however, are consistent with the results of CEG (2008) and Lajbcygier and Wheatley (2012). [57]

CEG (2008) and Lajbcygier and Wheatley (2012) show that there is evidence against the predictions of the SL CAPM for the cross section of mean returns to stocks while McKenzie and Partington (2012) show that there is evidence against the predictions of an intertemporal version of the SL CAPM on the *MRP*. [58] CEG and Lajbcygier and Wheatley show that there is no relation between mean return and beta across stocks while McKenzie and Partington

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

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

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

[55] McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012, pages 9-13.

[56] For example, employing almost two centuries' worth of US data, Lundblad documents a positive and significant relation between risk and return using a variety of models for volatility.

   Lundblad, C., *The risk return tradeoff in the long run: 1836-2003*, Journal of Financial Economics, 2007, pages 123-150.

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

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

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

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

   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

show that there is no relation between the *MRP* and the risk of the market portfolio through time.

While we do not dispute the evidence that McKenzie and Partington (2012) find against an intertemporal version of the SL CAPM, we do dispute the assertion that McKenzie and Partington make that an: [59]

> 'EGARCH model (provides) volatility estimates (that) are more consistent with events in the equity markets.'

2.3.1. Analysis

The exponential generalised auto-regressive conditional heteroscedasticity (EGARCH) model of Nelson (1991) allows for an asymmetric relation between future volatility and current returns and guarantees that forecasts of volatility are nonnegative. [60] Positive unexpected returns in the model can have a different impact on volatility than otherwise identical negative unexpected returns.

Before explaining why we dispute the assertion that McKenzie and Partington (2012) make, we note that it is obvious that Table 5 and Figure 7 in their report are incorrect. [61] First, the estimates from their Table 5 imply that the unconditional standard deviation of the return to the market portfolio in excess of the return to a bill is unreasonably high. We use the EGARCH parameter estimates of McKenzie and Partington's Table 5 to simulate a series of one million excess returns and find the standard deviation of the returns to be 42.65 per cent per annum. [62] The sample standard deviation of the return to the market portfolio in excess of the return to a bill computed from the annual data that Brailsford, Handley and Maheswaran (2012) and Handley (2012) provide and that we update is, in contrast, 17.04 per cent per annum.[63] Second, it is obvious that McKenzie and Partington's Figure 7 could not have been

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[59] McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012, page 5.

[60] Nelson, D., *Conditional heteroskedasticity in asset returns: A new approach*, Econometrica, 1991, pages 347-370.

[61] McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

[62] The model that McKenzie and Partington believe best fits the data is

$$r_t = 0.0667 + h_t^{1/2} z_t, \qquad z_t \sim \text{NID}(0,1), \qquad \log(h_t) = -0.8231 + 0.5702 \log(h_{t-1}) + 0.0947 |z_{t-1}| + 0.2018 z_{t-1},$$

where r_t denotes the annual return to the market portfolio in excess of the return to a bill. We set $\log(h_0)$ and z_0 to their unconditional means and then simulate 1,000,000 excess returns. The standard deviation of the simulated series is 42.65 per cent.

[63] Since we use annual data, and an intertemporal version of the SL CAPM places restrictions on the *MRP* relative to a short-term risk-free rate, we use the annual returns to a strategy of rolling over three-month bills as a measure of the risk-free rate rather than the yield to a 10-year bond.

Brailsford, Handley and Maheswaran (2012) provide series of market returns, with and without dividends, and series of bill returns and bond yields from 1883 to 2010. Handley (2012) provides series of market returns, with and without dividends, and a series of bond yields from 1883 to 2011. We compute a bill return for 2011 and credit yields for 1987 to 2011 in the same way that Brailsford, Handley and Maheswaran (2008, 2012) describe. We adjust returns for the provision of imputation credits under the assumption that the value of a one-dollar credit distributed has a market value of 35 cents. This value is the value laid down by the ACT in its recent decision on the market value of a one-dollar credit distributed.

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

produced using the parameter estimates in McKenzie and Partington's Table 5. Third, estimates over recent years of the conditional standard deviation in McKenzie and Partington's Figure 7 are unreasonably low.

Since the EGARCH evidence that McKenzie and Partington provide is unreliable, we use PROC AUTOREG of SAS to estimate the same EGARCH model that McKenzie and Partington claim to use. [64] Again, we use the annual return to the market portfolio in excess of the return to a bill using data from 1883 to 2011 that Brailsford, Handley and Maheswaran (2012) and Handley (2012) provide and that we update.[65]   Our estimates of an EGARCH model for the conditional standard deviation of the return to the market portfolio in excess of the return to a bill are

$$r_t = 0.0660 + h_t^{1/2} z_t, \qquad z_t \sim \text{NID}(0,1),$$

$$\log(h_t) = -1.3543 + 0.7707 \log(h_{t-1}) + 0.6501 |z_{t-1}| + 0.0391 z_{t-1}, \tag{1}$$

The variable h_t is the conditional standard deviation, z_t is the ratio of the unexpected return to the conditional standard deviation and NID means normally and independently distributed. We use these estimates to simulate a series of one million excess returns and find the standard deviation of the returns to be a more reasonable 18.01 per cent per annum. Our EGARCH estimates of the conditional standard deviation of the excess return to the market portfolio in excess of the return to a bill appear in Figure 2.7 below.

In our March 2012 report we indicate that the sample standard deviation of the return to the market portfolio from 1958 through 2011 is more than twice the sample standard deviation of the return from 1883 through 1957. [66] Figure 2.7 appears to suggest that the difference is smaller. An analysis of the standardised residuals generated by the EGARCH model shows why Figure 2.7 appears to suggest that the difference is smaller. A standardised residual is a residual divided by the conditional standard deviation of the residual. In other words, it is an estimate of the variable z_t in (1). The average squared standardised residual before 1958 is 0.66 while the average squared standardised residual from 1958 onwards is 1.46 and the difference between the two is significant at conventional levels. If the EGARCH model were to correctly describe the evolution of the excess return to the market portfolio, the expected

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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.

Handley, J., *An estimate of the historical equity risk premium for the period 1883 to 2011*, University of Melbourne, April 2012.

[64]   http://support.sas.com/documentation/cdl/en/etsug/60372/HTML/default/viewer.htm#etsug_autoreg_sect022.htm

[65]   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.

Handley, J., *An estimate of the historical equity risk premium for the period 1883 to 2011*, University of Melbourne, April 2012.

[66]   NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 63.

squared standardised residual each year would be one. So one would expect the average squared standardised residual to be around one both before and after 1958.

Figure 2.7
EGARCH estimates
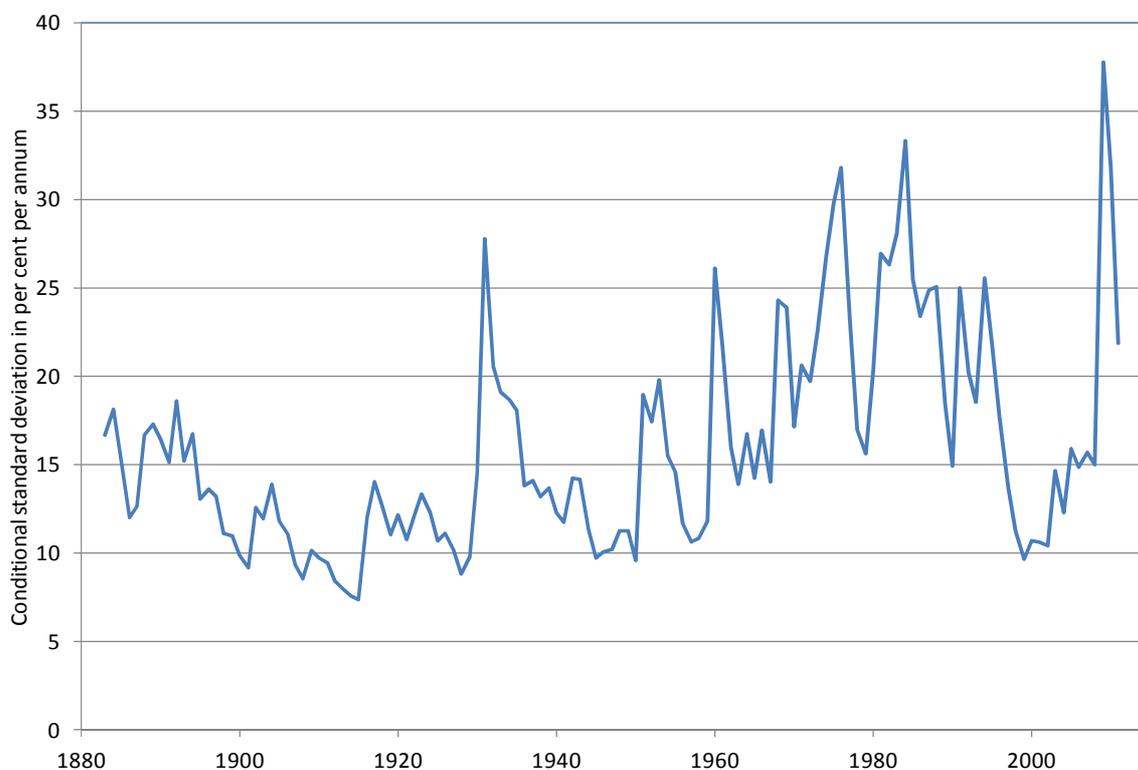
The low average squared standardised residual before 1958 and high average squared standardised residual from 1958 thereafter suggest that the EGARCH model may be misspecified. To illustrate why the model may be misspecified, we provide the results of additional simulations. The purpose of the simulations is to examine how an EGARCH model performs when there is a regime shift. In these simulations we assume that there is a single regime shift that occurs in 1958 when the standard deviation of the excess return to the market portfolio shifts from 10 per cent to 20 per cent per annum. We make this assumption because the data suggest that there was a shift in the standard deviation of the excess return at around that time and because the AER uses 1958 as a date at which to split the data into sub-periods. [67, 68] Also, because we wish to focus solely on the ability of an EGARCH model to detect a regime shift in volatility, we do not use the restriction that the model of Merton (1973) imposes on the *MRP* in constructing series of excess returns. [69] In other words,

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[67]   The data also suggest that there were short periods when the standard deviation was high before 1958 and low after 1958. The purpose of our simulations, though, is solely to examine whether an EGARCH model can successfully track regime shifts in the standard deviation of excess returns that last for many years.

[68]   AER, *Access arrangement draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

        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.

[69]   Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica, 1973, pages 867-887.

because our focus is on the ability of an EGARCH model to detect a shift in volatility, we assume that the *MRP* is a constant through time. We generate 10,000 series of excess returns for the period 1883 to 2011 under the assumption that a single regime shift occurs in 1958 when the standard deviation of the excess return to the market portfolio shifts from 10 per cent to 20 per cent per annum. In particular, we generate series that satisfy

$$r_t = 0.0600 + h_t^{1/2} z_t, \qquad z_t \sim \text{NID}(0,1),$$

$$h_t = 0.10, \quad t < 1958, \qquad h_t = 0.20, \quad t \geq 1958 \tag{2}$$

We then use the unrestricted regime-switching model and EGARCH model that McKenzie and Partington (2012) employ to estimate the conditional standard deviation of the return each year. [70] The unrestricted regime-switching model does not impose the restriction implied by Merton's model on the *MRP*.

Figure 2.8 plots the conditional standard deviation in per cent per annum for each year averaged across the 10,000 series for each model. It is clear that the EGARCH model has more difficulty in identifying the regime shift than the regime-switching model. The EGARCH model overestimates the conditional standard deviation in the low-volatility state and underestimates the conditional standard deviation in the high-volatility state. In the simulations the standard deviation of the excess return to the market is 10 per cent higher after 1958 than before 1958. The regime-switching model on average detects a difference of 7.23 per cent while the EGARCH model detects on average a difference of just 5.38 per cent.

These results and the evidence that the average squared standardised residual before 1958 is significantly lower than the average squared standardised residual from 1958 onwards suggest that it is *unclear* that the assertion that McKenzie and Partington (2012) make that an:

> 'EGARCH model (provides) volatility estimates (that) are more consistent with events in the equity markets.'

is correct. [71]

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[70] McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

[71] McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012, page 5.

Figure 2.8
Simulation evidence on the behaviour of EGARCH and regime-switching estimates of the volatility of the return to the market portfolio
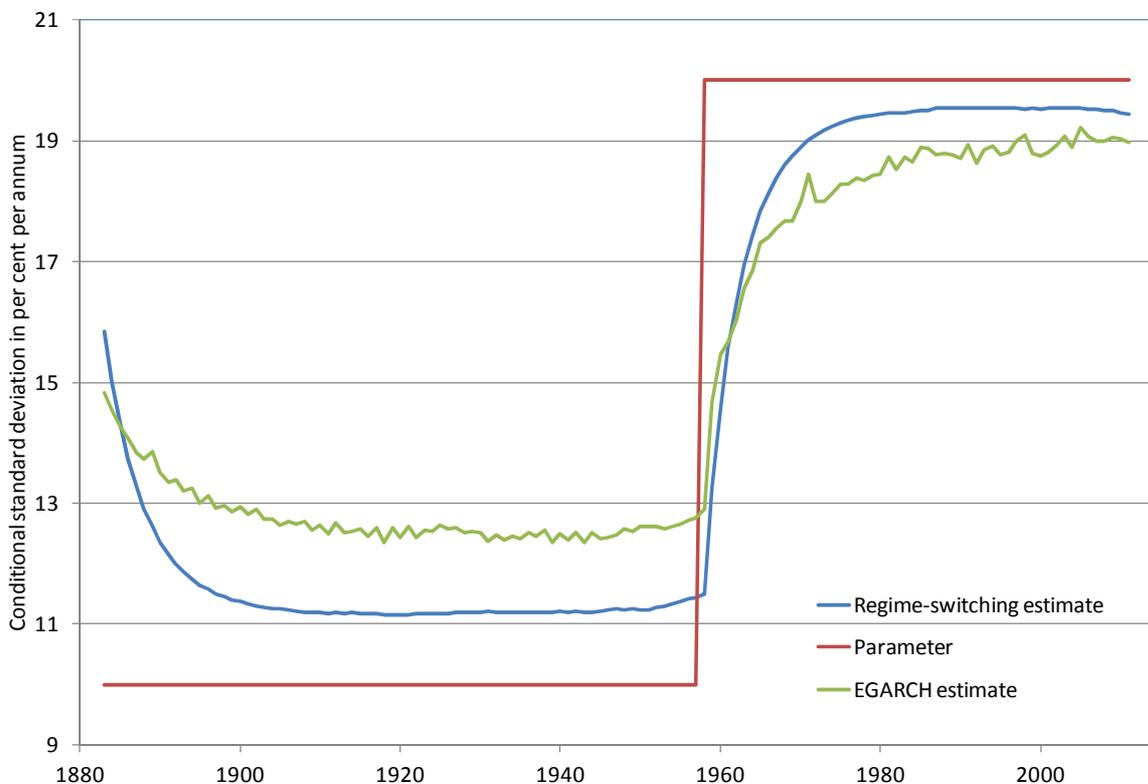
2.3.2. Summary

To summarise, we show that there is evidence that the EGARCH model that McKenzie and Partington (2012) introduce is misspecified. [72] Using the annual data from 1883 to 2011 that the AER employs and that we update, we provide statistically significant evidence that the model tends to overestimate the volatility of the return to the market portfolio when the volatility is low and tends to underestimate the volatility of the return to the market portfolio when the volatility is high. [73] Simulations that we conduct show that this is the result that one would expect to see if volatility underwent a regime shift. We recommend that the AER not use an EGARCH model with these data.

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[72]   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

[73]   AER, *Access arrangement draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

3.   Siegel Averaging

In a recent report for the AER, Lally (2012) argues, on the basis of evidence that Siegel (1992) provides, that the sample mean of a series of historical returns to the market portfolio in excess of the yield on a government bond can be an upwardly biased estimate of the long-run *MRP*. [74] Lally's argument is based on a view that investors have systematically underestimated inflation and that while the real returns to stocks are, in the long run, protected against unanticipated inflation, the real returns to bonds are not protected against unanticipated inflation. Lally argues that while investors have in the past underestimated inflation, they will not do so in the future. As a result, he argues that while the real return to the market portfolio in the future will on average be similar to its real return in the past the real return to a government bond in the future will on average be higher than it has been in the past. So Lally argues that an unbiased estimate of the long-run *MRP* going forward will be lower than the sample mean, computed from past data, of a series of returns to the market portfolio in excess of the government bond yield.

We show here that Lally's argument makes little sense because the available evidence does not support the idea that those whose business it is to forecast inflation – that is, professional forecasters – systematically underestimate inflation. Indeed, the available evidence also shows that those who are not professional forecasters do not systematically underestimate inflation. We identify periods over which individuals have underestimated inflation but these are matched by periods over which individuals have overestimated inflation. So it is difficult to see how the sample mean of a series of returns to the market portfolio in excess of the yield on a government bond can be viewed as an upwardly biased estimate of the long-run *MRP*.

In addition, we note that while Siegel examines the holding-period returns to bonds, the AER uses the yield on a new 10-year bond each year in estimating the long-run *MRP*. Moreover, the AER measures the yield at the end of each year. These two factors will limit the impact that unanticipated inflation can have on the excess returns that the AER uses to estimate the long-run *MRP*.

3.1. Theory

Siegel (1992) examines the behaviour of US bill, bond and stock returns from 1802 to 1990 and finds that: [75]

> 'the real rate of return on equity held remarkably constant over this period, while the real return on fixed income assets declined dramatically.'

Table 3.1 below summarises his results. The real returns to bills and bonds are the real holding-period returns to the assets.

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[74]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 28-29.

[75]   Siegel, J., *The equity premium: Stock and bond returns since 1802*, Financial Analysts Journal, January-February 1992, page 28.

Siegel considers that one explanation for the decline in the real returns provided by bonds might be that unanticipated inflation between 1926 and 1990 depressed real bond returns, because bonds are financial assets, but did not depress stock returns, because stocks are claims on real assets. For example, Siegel states that: [76]

> 'although the data demonstrate that returns on equities have compensated investors for increased inflation over the post-war period, the returns on fixed income securities have not. One possible explanation is that lenders did not anticipate inflation during much of the period.
>
> One could argue that a large part of the increase in the price level since World War II, especially since 1970, was unanticipated, hence bondholders did not have a chance to adjust their required returns. The progressive abandonment of the gold standard only slowly reduced investors' convictions about the stability of the long-run price level.
>
> Unanticipated inflation certainly lowered the real return on long-term bonds. Buyers of such instruments in the 1960s and early 1970s could scarcely have imagined the double-digit inflation that followed.'

Table 3.1
Arithmetic average real returns to US bills, bonds and stocks: 1802-1990

Period	Bills	Bonds	Stocks
1802-1870	5.4	5.2	6.9
1871-1925	3.3	4.0	7.9
1926-1990	0.6	1.8	8.6

Note: Estimates are from Tables I and II of Siegel (1992). Arithmetic average real returns in per cent per annum are shown before tax. Siegel, J., The equity premium: Stock and bond returns since 1802, Financial Analysts Journal, January-February 1992, pages 28-36+48.

Siegel notes, however, that the same argument cannot be used to explain the decline in the real returns to bills, evident in Table 3.1, because the exposure of short-term bonds like bills to unanticipated inflation is limited. For example, he states: [77]

> 'But unanticipated inflation is less important for short-term bonds. The inflationary process, although increasingly subject to long-term uncertainty, has been quite persistent and inertial in the short run. Short-term investors thus have a better opportunity to capture the inflation premium in the rate of interest as they roll over their investments. Short-term bonds should therefore provide better protection against unanticipated inflation than longer-term bonds.'

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[76] Siegel, J., *The equity premium: Stock and bond returns since 1802*, Financial Analysts Journal, January-February 1992, page 36.

[77] Siegel, J., *The equity premium: Stock and bond returns since 1802*, Financial Analysts Journal, January-February 1992, page 36.

Siegel nevertheless states that: [78]

> 'this protection is not perfect; unanticipated inflation may account for up to one percentage point of the decline in the real yield on short-term bonds over the sample period.
>
> This has been suggested to me by some preliminary work done by Charles Calomaris.'

Although Siegel is not clear about from where Calomaris produced an estimate of one percentage point, it is likely that the estimate was produced using the Livingston survey of business economists and data from the inception of the survey in 1946 until 1990. We show below that this estimate of average unanticipated inflation does not differ significantly from zero at conventional levels and, in addition, that an estimate that uses data from 1946 to 2012 is only half as large and also not significantly different from zero at conventional levels. Moreover, we show that an estimate of average unanticipated inflation computed using the ASA-NBER survey of professional forecasters is smaller still and is also not significantly different from zero.

3.2. Data

To examine whether market participants have in the past underestimated the level of inflation we use two surveys: the Livingston survey of business economists and the American Statistical Association (ASA) and the National Bureau of Economic Research (NBER) survey of professional forecasters.

3.2.1. Livingston survey

In 1946, Joseph A. Livingston, then a columnist for the *Philadelphia Record,* began asking business economists whom he knew to provide him with their forecasts for important economic variables – including the consumer price index. He conducted the survey every six months, in June and December, continuing the survey when he moved from the *Record* to the *Bulletin* in 1948 and to the *Philadelphia Inquirer* in 1972. On Livingston's death in 1989, the Philadelphia Federal Reserve took over the running of the survey.

For simplicity, we focus our analysis on forecasts made in December of each year. The December survey is mailed to participants in November of each year, immediately after the government's release of the consumer price index (CPI) for October and the Fed requests that the survey be returned before the release of the CPI for November. Each participant is asked to make forecasts at a number of horizons. We focus on forecasts made of the rate of change in the CPI – that is, inflation – on an annual basis from the end of June of the following year to the end of December of the following year. We do so because until 1992 participants were not asked in December to forecast the CPI for that month – which along with the CPI for November would not have been announced before participants returned their surveys.

Each year, we compare the medians of the inflation forecasts made by participants with the actual level of inflation computed on an annual basis from June to December. Prior to December 2004, participants were asked to provide forecasts that were not seasonally

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[78]   Siegel, J., *The equity premium: Stock and bond returns since 1802*, Financial Analysts Journal, page 36.

adjusted whereas from December 2004 onwards they were asked to provide seasonally adjusted forecasts. We compare the forecasts with the corresponding series for the CPI All Urban Consumers All Items taken from the Bureau of Labor Statistics. [79]

3.2.2. ASA-NBER survey

The ASA-NBER survey has asked professional forecasters for predictions of a large number of economic variables four times each year since 1968. The Philadelphia Federal Reserve now also runs this survey. For simplicity, we focus on forecasts made in the last quarter of each year of the rate of change in the GDP price index – that is, inflation – between the second and fourth quarters of the following year. We do so because when participants return their surveys they do not know the value of the index in the fourth quarter – and participants during the fourth quarter are not asked to forecast the value of the index in the fourth quarter.

We compare the medians for each year of the inflation forecasts made by participants with the actual level of inflation computed on an annual basis from the second to the fourth quarter of each year. Prior to 1992, participants were asked to provide forecasts not of the GDP price index but instead of the GNP price deflator while from 1992 to 1995 they were asked to provide instead forecasts of the GDP implicit price deflator. We compare the forecasts participants make with the percentage change in the corresponding price variable taken from the Federal Reserve of St Louis web site. [80]

3.2.3. Bond data

Besides examining whether forecasts of inflation made by the Livingston and ASA-NBER survey participants are rational, we also test for a link between unanticipated inflation and bond holding-period returns and between unanticipated inflation and bond yields. We use monthly holding-period returns to a portfolio of long-term government bonds from the *Ibbotson SBBI 2012 Classic Yearbook* and we use the yields on 10-year government bonds from the Board of Governors of the Federal Reserve System web site. [81]

3.3. Evidence

3.3.1. Rationality

Figure 3.1 plots unanticipated inflation over the second half of each year computed using the two surveys. Unanticipated inflation is actual inflation less forecast inflation. It is clear that forecasts made by participants in the Livingston survey were very poor for the first few years. Survey participants forecast deflation in the four years from 1947 to 1950 but prices rose rapidly in both 1947 and 1950 – falling only in 1949. [82] It is also evident that both the

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[79]   The not seasonally adjusted series is CUUR0000SA0 while the seasonally adjusted series is CUSR0000SA0.

[80]   The GNP implicit price deflator series is GNPDEF, the GDP implicit price deflator series is GDPDEF while the GDP price index series is GDPCTPI.

[81]   The 10-year bond yield series is H15_TCMNOM_Y10_MONTHLY.

[82]   Aizenman and Marion argue that the large public debt accumulated by the U.S. by the end of World War II and the longer maturities attached to the debt provided an incentive for the Federal Reserve to inflate away some of the burden.

Aizenman, J. and N. Marion, *Using inflation to erode the U.S. public debt*, NBER, 2009.

Livingston and ASA-NBER forecasts tend to underestimate inflation up until the appointment of Paul Volcker as Chairman of the Federal Reserve and overestimate inflation thereafter. Paul Volcker was appointed Chairman of the Federal Reserve in July 1979 and is generally credited with bringing inflation in the U.S. under control. [83] On average over time, however, it appears that neither survey systematically underestimates or overestimates inflation.

Figure 3.1
ASA-NBER and Livingston measures of unanticipated inflation
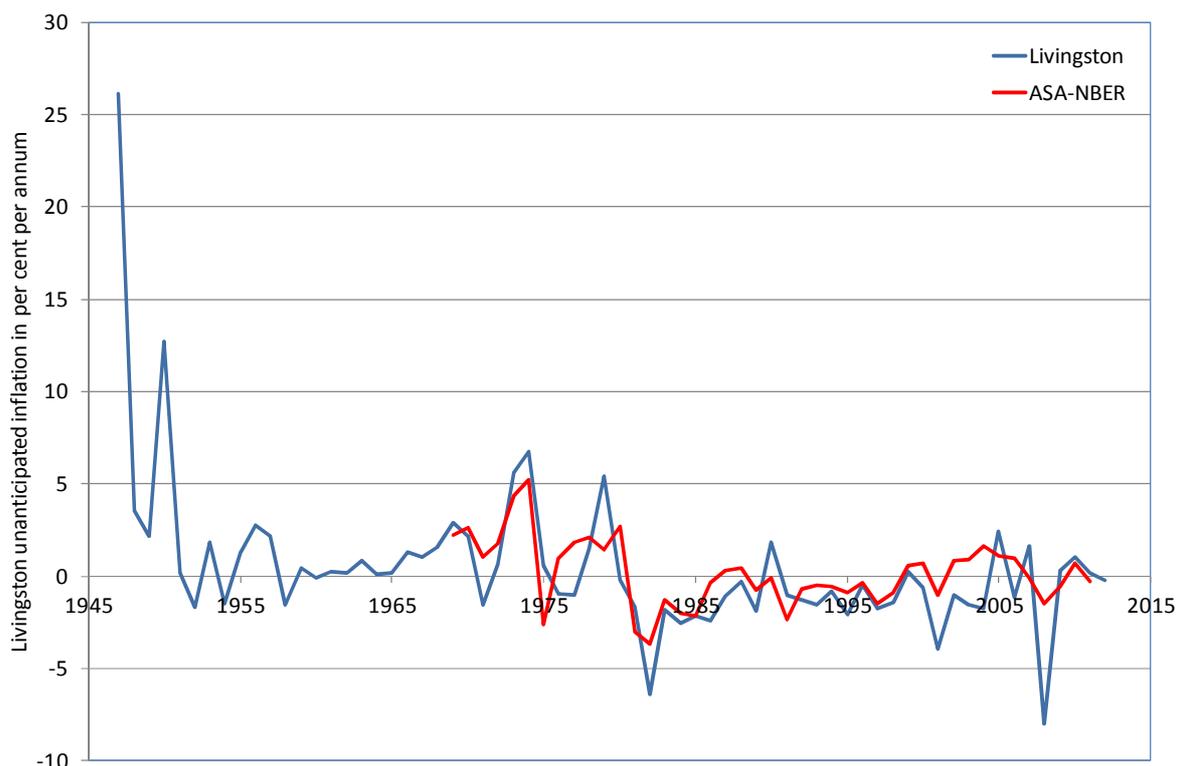
These inferences are confirmed by tests, the results for which appear in Table 3.2. There is no evidence that in the long run either the Livingston or ASA-NBER participants systematically underestimate inflation.

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[83]   See, for example, Poole (2005).

Poole, W., *Volcker's handling of the great inflation taught us much*, The Regional Economist, St Louis Federal Reserve, 2005.

Table 3.2
Rationality of Livingston and ASA-NBER inflation forecasts

Survey	Sample mean of unanticipated inflation in per cent per annum			
	1947-1990	1947-2012	1947-1979	1980-2012
Livingston	1.298	0.517	2.294*	-1.260*
	(0.733)	(0.526)	(0.894)	(0.355)
	1969-1990	1969-2011	1969-1979	1980-2011
ASA-NBER	0.499	0.165	1.908*	-0.434
	(0.502)	(0.280)	(0.603)	(0.240)

*Note: Data are from the Bureau of Labor Statistics, the Federal Reserve of Philadelphia and the Federal Reserve of St Louis. Sample means are outside of parentheses while standard errors are in parentheses. * indicates significantly different from zero at the 5 per cent level.*

3.3.2. Bond returns, bond yields and unanticipated inflation

If inflation is persistent, then unanticipated inflation can raise expectations of future inflation. It follows that if bond yields reflect the market's expectation of future inflation, holding-period returns on bonds will be negatively related to unanticipated inflation while changes in bond yields will be positively related to unanticipated inflation. The holding-period return to a bond from time *t* to time *t*-1 is defined to be:

$$\frac{P(t) + C(t) - P(t-1)}{P(t-1)} \tag{3}$$

where

$P(t)$ =   the price of the bond at time *t* ;

$C(t)$ =   the coupon the bond pays at time *t*.

Table 3.3 below shows that this expectation is borne out. Moreover, the results in the table demonstrate that, consistent with expectations, bond returns are more sensitive to unanticipated inflation than bond yields. In other words, the slope coefficient estimates in the bond return column are larger than the slope coefficient estimates in the yield change column. The reason for this difference is that an increase in the yield on a long-term bond of one per cent will be associated with a decline of far more than one per cent in its price.

While Siegel examines the holding-period returns to bonds, the AER uses the yield on a new 10-year bond each year in estimating the long-run *MRP*. In addition, the AER measures the yield at the end of each year. Table 3.3 suggests that these two factors will limit the impact that unanticipated inflation can have on the excess returns that the AER uses to estimate the long-run *MRP*. First, the impact of unanticipated inflation on bond returns is much larger

than on bond yields. Second, the AER measures the yield on a bond at the end of each year at which time the impact of unanticipated inflation over the year will have been incorporated into the yield.

Table 3.3
Bond returns, bond yields and unanticipated inflation

Survey	Bond returns	Bond yield changes
Livingston (1953 – 2012)	-1.617*	0.168*
	(0.553)	(0.061)
ASA-NBER (1969 – 2011)	-2.133*	0.255*
	(0.854)	(0.110)

*Note: Data are from the Bureau of Labor Statistics, the Board of Governors of the Federal Reserve, the Federal Reserve of Philadelphia and the Federal Reserve of St Louis. Slope coefficients from regressions of bond returns or bond yield changes on unanticipated inflation are outside of parentheses while heteroscedasticity and autocorrelation consistent standard errors are in parentheses. * indicates significantly different from zero at the 5 per cent level.*

3.4. QCA Estimates

The Queensland Competition Authority (QCA) (2012) uses Lally's suggestion and computes an estimate of the long-run *MRP* for Australia of 4.32 per cent per annum. [84] The QCA should arrive at this figure by subtracting the difference between what it deems to be the long-run real yield, 4 per cent, and the average real holding-period return from 1900 to 2000 of 1.9 per cent that Dimson, Marsh and Staunton (2002) report, from an estimate of the with-imputation-credit *MRP* taken from Brailsford, Handley and Maheswaran (2012) of 6.21 per cent per annum. [85] That is, the figure that the QCA should have produced should have been:

$$6.21 - (4.00 - 1.90) = 4.11 \text{ per cent per annum} \tag{4}$$

Clearly, however, the QCA has made an arithmetical error and has instead subtracted the long-run real yield of 1.9 per cent from the with-imputation-credit *MRP* of 6.21 per cent per annum. Regardless of how the QCA arrived at the figure, though, the QCA assumes that investors have underestimated inflation by around two per cent each year over the 128-year period from 1883 to 2010. The evidence that we provide suggests that this assumption is not credible.

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[84]   QCA, The risk-free rate and the market risk premium, November 2012, page 11.

[85]   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.

Dimson, E., P. Marsh, and M. Staunton, *Triumph of the Optimists*, Princeton University Press: Princeton, New Jersey, United States, 2002.

4.   Practitioner Behaviour

4.1. Surveys

In choosing a value for the *MRP* the AER places some weight on survey evidence. For example, the AER states in its September 2012 *Draft Decision* that: [86]

> 'It considers surveys of market practitioners and academics are relevant because they reflect the forward looking MRP as applied.'

We emphasise in our March 2012 report, however, that there are a number of problems with the surveys that the AER cites: [87]

- the surveys that the AER cites typically do not explain how those surveyed were chosen;

- a majority of those surveyed in the surveys that the AER cites did not respond;

- it is unclear what incentives were provided to individuals contacted by the surveys that the AER cites to ensure that respondents would provide accurate responses;

- it is unclear whether respondents are supplying estimates of the *MRP* that use continuously compounded returns or not continuously compounded returns;

- it is often unclear what value respondents place on imputation credits;

- it unclear what risk-free rate respondents use; and importantly

- it is unclear how relevant some of the surveys that the AER cites are because of changes in market conditions since the time at which the surveys were conducted.

The Australian Competition Tribunal (ACT) also urges the AER to treat the results of surveys with caution. For example, the ACT states that: [88]

> 'Surveys must be treated with great caution … consideration must be given at least to … the number of respondents, the number of non-respondents and the timing of the survey.'

> 'When presented with survey evidence that contains a high number of non-respondents as well as a small number of respondents in the desired categories of expertise, it is dangerous for the AER to place any determinative weight on the results.'

The AER states in its September 2012 *Draft Decision*, on the other hand, that: [89]

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[86]   AER, *Draft Distribution Determination Aurora Energy Pty Ltd 2012–13 to 2016–17*, November 2011, page 98.

[87]   NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 43.

[88]   Australian Competition Tribunal, *Application by Envestra Limited (No 2) [2012] ACompT 3*, 11 January 2012, paragraphs 165–166.

[89]   AER, *Draft Distribution Determination Aurora Energy Pty Ltd 2012–13 to 2016–17*, November 2011, page 98.

> 'Survey based estimates may be subjective … however, this concern may be
> mitigated as the sample size increases.'

This statement assumes that the error with which surveys estimate the *MRP* can be diversified
away across surveys. This need not be true. For example, if all of the surveys were
conducted at a time when the *MRP* was low, then they will all tend to underestimate the *MRP*
and the error that they make in estimating the current *MRP* will not be diversified away.

As an example of the problems that can arise, we note that with regard to one of the most
recent surveys to which the AER refers, the survey conducted by Asher (2011), that: [90]

- only 49 of 2,000 surveyed responded; and that

- the survey was conducted in February 2011 when bond yields and were around 250
  basis points higher than in September 2012. [91]

The low number of responses raises the possibility that the sample of respondents is not
representative of the population. The timing of the survey suggests that the results of the
survey are, in any case, of little relevance to constructing a value for the *MRP* that reflects
currently prevailing conditions.

An alternative source for a guide as to what market participants believe is an appropriate
value for the *MRP* is in independent expert reports.

4.2. Independent Expert Reports

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 how returns are measured, that is, whether
  returns are continuously compounded or not continuously compounded;

- 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.

In addition, the AER, in its September 2012 *Draft Decision* states that: [92]

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[90]   Asher, *Equity Risk Premium Survey – results and comments*, Actuary Australia 2011 Issue 161, July 2011, pages. 13-
        15.

[91]   The RBA reports that the 10-year bond yield on 11 September 2012 was 3.04 per cent per annum while it was 5.66 per
        cent per annum on 11 February 2011. See

        www.rba.gov.au/statistics/tables/xls/f02dhist.xls

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

Thus the AER and at least two of its advisors believe that independent expert reports can provide information that is useful in determining the *MRP*.

Independent experts estimate the cost of equity so as to value certain transactions. The cost of equity is typically estimated and then blended with a cost of debt to establish a *WACC* which is then used to discount future cash flows expected if a transaction were to proceed. The present value of the transaction may be compared with the present values of alternatives to the transaction, including the alternative of not proceeding with the transaction.

The Corporations Act and the ASX Listing Rules specify the circumstances under which an expert report must be issued to shareholders who may be affected by certain types of transactions. Even where there is no requirement for an expert report under the Corporations Act or the ASX Listing Rules, the directors of a company may still voluntarily commission an expert report to assist security holders to make informed decisions in relation to certain proposals.

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. Section 9 of the Corporations Act defines an expert as: [93]

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

ASIC requires that experts who prepare independent expert reports:

a. cannot be associated with certain parties who have interests in the transaction for which the independent expert report is prepared;

b. must disclose certain relevant interests and relationships when preparing reports required by the Corporations Act; and

c. must hold an Australian financial services licence which imposes obligations to manage potential conflicts of interest.

In paragraph 111.128 of Regulatory Guide 111 ASIC advises that it will consider regulatory action if it considers there are material issues about the adequacy and completeness of an independent expert's analysis, or if it has concerns about the expert's independence. Regulatory action may include revocation or suspension of the independent expert's licence.

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[92] 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.

[93] Commonwealth Government, Corporations Act, 2001.

4.3. The Connect 4 Data

We use data collected from the Connect 4 database by Ernst and Young who employ the data in their November submission to the AER on behalf of the APA Group, Envestra, Multinet and SP AusNet. [94] These data cover all 889 independent expert reports issued between 1 January 2008 and 10 October 2012 that are published in the Connect 4 Expert Reports database. Connect 4 is a web-based system, operated and maintained by the Thomson Reuters company, which provides information on companies listed on the ASX.

Of the 889 independent expert reports, 267 reports include a valuation of a transaction and employ a discounted cash flow valuation method. Of these 267 reports, 167 reports use the CAPM to derive the cost of equity. Of the 167 reports that use the CAPM, four do not provide sufficient information on how the cost of equity is estimated and so are discarded. Of the remaining 163 expert reports, 27 reports estimate the cost of equity using data from foreign markets – like, for example, a foreign bond yield to measure the risk-free rate. A further four reports rely on short-term Commonwealth government bond yields and so are also discarded. Thus 132 reports qualify for a more detailed analysis of the assessments that independent experts make of the *MRP*.

4.4. Independent Expert Assessments of the *MRP*

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*.

In addition, our own examination of the data reveals that in 61 of the 132 expert reports a firm-specific premium is added to the cost of equity. The CAPM predicts that the premium that an asset will earn over and above the risk-free rate will be determined solely by the contribution of the asset to the risk of the market portfolio, measured by its beta, and the price of risk, measured by the *MRP*. Thus an expert who adds a firm-specific risk premium to the cost of equity is not relying solely on the CAPM.

4.4.1. Extracting expert assessments of the *MRP*

The extent to which each independent expert discusses how values for the parameters of the CAPM are chosen varies both across experts and through time. For example, BDO's discussion of the value that it chooses for the *MRP* in its November 2009 valuation of Excela consists of four sentences. BDO states that: [95]

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[94]   Ernst and Young, *Market evidence on the cost of equity Victorian Gas Access Arrangement Review 2013-2017*, 8 November 2012

[95]   BDO, *Independent expert report: Fox Invest Limited*, 25 November 2009, page 41.

'The market risk premium is the difference between the expected return on the market and the risk free rate. It represents the "undiversifiable risk" attached to all equity investments.

According to empirical evidence the market risk premium is historically between 6% and 8%. We adopted a market risk premium of 6.50% in our valuation of Excela.'

In contrast, Grant Samuel's discussion of the value that it chooses for the *MRP* in its August 2012 valuation for Hastings Diversified Utilities Fund covers more than one page. Grant Samuel states initially that: [96]

'Grant Samuel has consistently adopted a market risk premium of 6% and believes that, particularly in view of the general uncertainty, this continues to be a reasonable estimate. It:

- is not statistically significantly different to the premium suggested by long term historical data;

- is similar to that used by a wide variety of analysts and practitioners (typically in the range 5-7%); and

- makes no explicit allowance for the impact of Australia's dividend imputation system.'

This initial statement, however, is followed by a more detailed analysis that states that: [97]

'Grant Samuel's view is that the selected cost of capital should incorporate a margin over the calculated WACC range to reflect:

- alternative approaches for estimating the cost of equity such as the Gordon Growth Model suggest higher rates than the 7.5-8.1% implied by the CAPM. Analysis of the entities most comparable to Epic Energy (i.e. APA Group, DUET Group and Envestra) using the Gordon Growth Model suggests costs of capital in the range 9.5-12% (yields mostly around 7.5% and growth of 2.0-3.0%) with a median of around 10.5%. The Gordon Growth Model is an alternative approach to estimating the cost of equity under which it is calculated as the current forecast yield plus the expected long term growth rate. This approach is particularly useful when valuing assets which generate long term stable growth cash flows such as energy infrastructure assets. However, caution is warranted in considering this analysis because of the difficulties of putting the yields of the energy infrastructure entities on a comparable basis because of differing tax treatments;

- anecdotal information suggests that equity investors have substantially repriced risk since the global financial crisis (notwithstanding the uplift in equity markets since March 2009) and that acquirers are pricing offers on the basis of hurdle rates well above those implied by theoretical models. This can be evidenced through the decline in listed company earnings multiples (relative to the peak in 2007) although it has yet to be translated into the measures of market risk premium (at least those based on longer term historical data). Another way of looking at this is to note that while long term interest rates have fallen by approximately 150-200 basis points over the past 12 months there has been no

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[96] Grant Samuel, *Independent expert's report: Pipeline Partners Offer*, 3 August 2012, page 6.

[97] Grant Samuel, *Independent expert's report: Pipeline Partners Offer*, 3 August 2012, pages 8-9.

corresponding lift in earnings multiples, suggesting investors have offset this reduction with an increase in their risk premium and/or a reduction in long term earnings growth rates. In this regard, an increase in the market risk premium of 1% (i.e. from 6% to 7%) would increase the calculated WACC range to 6.6-7.2%;

- global interest rates, including long term bond rates, are at very low levels by comparison with historical norms reflecting the very substantial amounts of liquidity being pumped into many advanced economies (particularly Western Europe and the United States) to stimulate economic activity. Effective real interest rates are now extremely low, if not negative in some cases (e.g. the United States). We do not believe this position is sustainable and, in our view, the risk is clearly towards a rise in bond yields. Conceptually, the interest rates used to calculate the discount rate should recognise this expectation (i.e. they should be forecast for each future period) but for practical ease market practice is that a single average rate based on the long term bond rate is generally adopted for valuation purposes. Some academics/valuation practitioners consider it to be inappropriate to add a "normal" market risk premium (e.g. 6%) to a temporarily depressed bond yield and therefore a "normalised" risk free rate should be used. On this basis, an increase in the risk free rate to (say) 5% would increase the calculated WACC range to 7.2-7.9%; and

- analysis of research reports on Australian entities involved in gas transmission operations (i.e. HDUF, APA Group, DUET Group and Envestra) indicates that brokers are currently adopting costs of equity capital in the range 9.1-12.0%, with a median of 10.6% and WACC in the range 7.3-8.8%, with a median of 7.8%.

Having regard to these matters and the calculations set out above, Grant Samuel has selected a discount rate range of 8.0-8.5% for application in the discounted cash flow analysis.'

In the 10 instances where an independent expert sets a value for the *MRP*, calculates a value for the cost of equity and then subsequently produces a revised value either for the cost of equity or the *WACC* that exceeds 25 basis points per annum, we record two values for the *MRP*. First, we record the initial value for the *MRP* that the expert chooses. We label this value the unadjusted value of the *MRP*. Second, we compute an adjusted value under the assumption that any difference between the final choice for a cost of equity or *WACC* and the initial value for a cost of equity or *WACC* is due solely to an adjustment to the *MRP*. We make this assumption because the 10 reports that make a final adjustment to the cost of equity or *WACC* do not specify what portion of the adjustment is due to an adjustment made to the *MRP*. We view the adjusted and unadjusted values of the *MRP* as providing upper and lower bounds for the parameter.

We also examine the independent expert reports to assess whether any further adjustments to the cost of debt have been made. In particular, we look for evidence as to whether any final revisions to the *WACC* (or to the discount rate) can be attributed to amendments to the cost of debt. In almost every instance, there is no commentary to suggest that a change to the cost of debt is responsible for any adjustment to the *WACC* (or to the discount rate).

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

$$WACC(\text{final}) - WACC(\text{initial}) = \left(1 - \frac{D}{V}\right)\beta(MRP(\text{final}) - MRP(\text{initial})),\qquad(5)$$

where D/V is the fraction of the firm's value made up of debt outstanding and β is the firm's equity beta. It follows that

$$MRP(\text{final}) = MRP(\text{initial}) + \frac{(WACC(\text{final}) - WACC(\text{initial}))}{\left(1 - \frac{D}{V}\right)\beta}\qquad(6)$$

For the Grant Samuel August 2012 valuation for Hastings Diversified Utilities Fund: [98]

- 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 an adjusted *MRP* in per cent per annum of:

$$6 + \frac{2 \times ((8.0 + 8.5) - (6.3 + 6.8))}{(0.45 + 0.55)(0.75 + 0.85)} = 10.25\qquad(7)$$

For the Grant Samuel August 2012 valuation for Hastings Diversified Utilities Fund, the unadjusted value of the *MRP* is 6 per cent per annum. [99]

From the discussion that we reproduce above from the Grant Samuel August 2012 report for Hastings Diversified Utilities Fund it is evident that the view of Grant Samuel is that the *MRP* lies above 6 per cent per annum. It is also evident from the discussion that Grant Samuel views estimates of the cost of equity generated by the CAPM as too low. Thus one cannot attribute all of the final adjustment that Grant Samuel makes to the *WACC* to an adjustment to the *MRP*. Part of the final adjustment appears to reflect Grant Samuel's belief that the CAPM omits factors that are important in pricing the equity of a regulated utility. Thus a reasonable interpretation is that the adjusted value of 10.25 per cent per annum represents an upper bound on the value that Grant Samuel believes the *MRP* should take and that the unadjusted value of 6 per cent per annum represents a lower bound.

Ernst and Young (2012) compute instead an adjusted value of the *MRP* under the implicit assumption that any difference between the final choice of a *WACC* and the initial value for the *WACC* is due solely to an adjustment to the risk-free rate. [100] We report evidence below that over the last two years some experts set the risk-free rate above the 10-year CGS yield.

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

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

[100]   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 23.

Thus the assumption that Ernst and Young make is a reasonable alternative to the assumption that we make about how experts make a final adjustment to the *WACC*.

Finally, we note before proceeding to the results of our empirical analysis that Ernst and Young report that the values of the *MRP* that the 132 independent experts use are not adjusted for the value that imputation credits provide to some investors. [101] Grant Samuel, for example, state in their August 2012 valuation for Hastings Diversified Utilities Fund that: [102]

> 'the evidence gathered to date as to the value the market attributes to franking credits is insufficient to rely on for valuation purposes. More importantly, Grant Samuel does not believe that such adjustments are widely used by acquirers of assets at present.'

> 'it is Grant Samuel's opinion, that it is not appropriate to make any adjustment.'

4.4.2. Regression analysis of independent expert assessments of the *MRP*

The AER follows a policy of setting the *MRP* to be approximately a constant, 6 per cent per annum, through time that is independent of the risk-free rate. [103] We use the 132 independent expert assessments of the *MRP* to test whether this policy is consistent with market practice. To do so, we examine the behaviour of:

(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, $MRP_{\mathrm{IER}} + RFR_{\mathrm{IER}} - RFR_{CGS}$; [104]

(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, $RFR_{\mathrm{IER}} - RFR_{CGS}$,

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 4.1 provides the results of these regressions. Panel A provides results that use the unadjusted data while Panel B provides results that use the adjusted data.

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[101]   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.

[102]   Grant Samuel, *Independent expert's report: Pipeline Partners Offer*, 3 August 2012, page 10.

[103]   The AER raised the *MRP* in May 2009, in the face of the global financial crisis, to 6.5 per cent per annum but brought it back down again to 6 per cent in February 2011 after it judged the crisis had past.

   AER, *Final decision: Electricity transmission and distribution network service providers: Review of the weighted average cost of capital (WACC) parameters*, May 2009.

   AER, *Draft decision: Envestra Ltd Access arrangement proposal for the SA gas network 1 July 2011 – 30 June 2016*, February 2011.

[104]   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.

Panel A indicates that one can reject the proposition that an estimate of the return required on the market portfolio taken from an independent expert report in excess of the 10-year CGS yield is independent of the yield. An estimate of the return required on the market portfolio taken from an independent expert report in excess of the 10-year CGS yield is an estimate of the *MRP* that independent experts use measured in exactly the same way that the AER measures the *MRP* – that is, relative to the 10-year CGS yield.

An estimate of the *MRP* relative to the 10-year CGS yield of 3.555 per cent for 21 February 2013 based on the first regression in Panel A of Table 4.1 is, in per cent per annum,

$$7.176 - 0.155 \times 3.555 = 6.625 \tag{8}$$

This figure is exclusive of a value assigned to imputation credits.

Table 4.1
Analysis of independent expert assessments of the *MRP*

Dependent variable	Intercept	Slope
Panel A: Data unadjusted		
$MRP_{IER} + RFR_{IER} - RFR_{CGS}$	7.176*	-0.155*
	(0.241)	(0.048)
MRP_{IER}	6.034*	0.046
	(0.226)	(0.046)
$RFR_{IER} - RFR_{CGS}$	1.142*	-0.201*
	(0.217)	(0.040)
Panel B: Data adjusted		
$MRP_{IER} + RFR_{IER} - RFR_{CGS}$	8.361*	-0.370*
	(0.642)	(0.121)
MRP_{IER}	7.219*	-0.170
	(0.714)	(0.134)
$RFR_{IER} - RFR_{CGS}$	1.142*	-0.201*
	(0.217)	(0.040)

*Note: Data are from the Connect-4 database 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 file f16.xls. The results are generated by regressing each dependent variable on RFR_{CGS}. Standard errors are in parentheses and are heteroscedasticity and autocorrelation consistent. * indicates significantly different from zero at the 5 per cent level.*

Panel A of Table 4.1 also shows, interestingly, that the negative relation between an estimate of the return required on the market portfolio taken from an independent expert report in excess of the 10-year CGS yield and the yield arises not because of a relation between the value for the *MRP* that experts provide and the yield. Instead the relation arises from a tendency for independent experts to substitute a higher value for the risk-free rate than the 10-year CGS yield when yields fall. This can be inferred from the negative slope coefficient that results from regressing the difference between the risk-free rates chosen by independent experts and the 10-year CGS yield on the CGS yield. Figure 4.1 illustrates this tendency and demonstrates that it is a relatively recent phenomenon. In the 32 reports from 4 October 2011 to 3 October 2012 independent experts set the risk-free rate on average 44 basis points above the 10-year CGS yield. In the 100 reports from 2 January 2008 to 3 October 2011 independent experts set the risk-free rate on average 4 basis points above the 10-year CGS yield.

Figure 4.1
Relation between independent expert and RBA measures of the risk-free rate
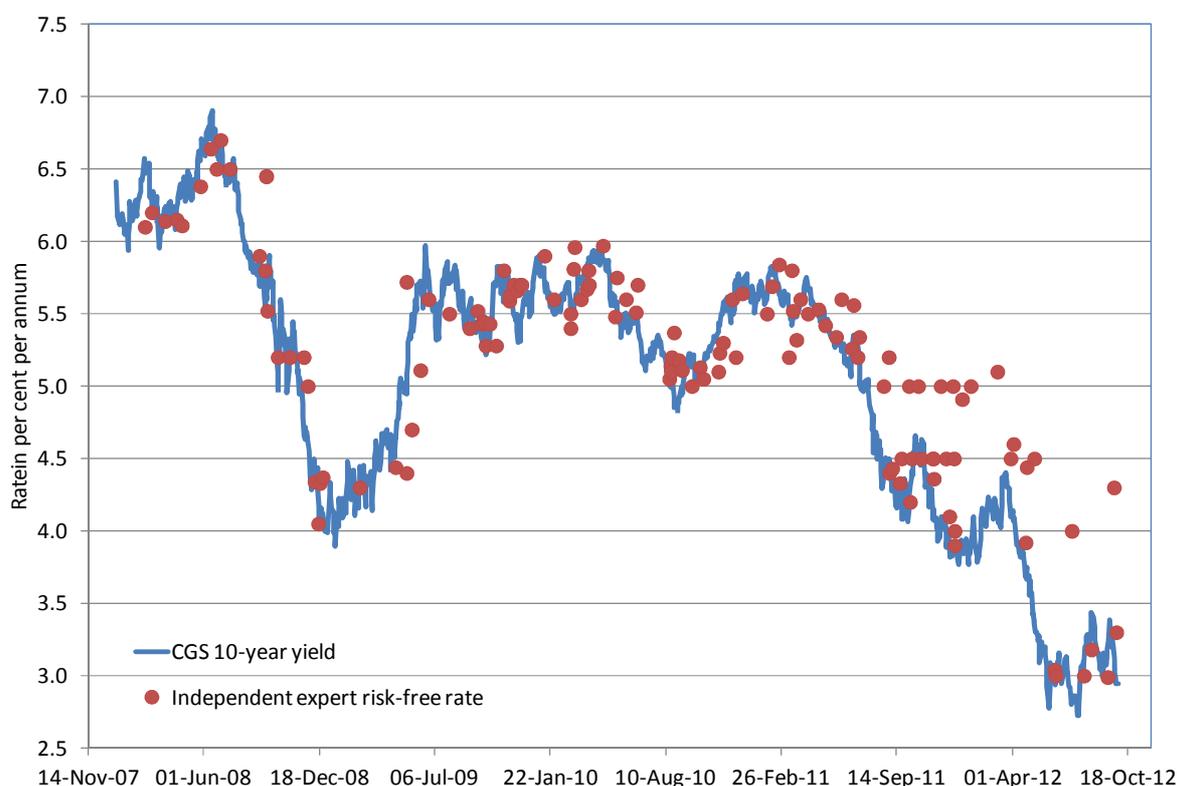
Panel B of Table 4.1 provides results that use the adjusted data. The panel indicates that, as with the unadjusted data, one can reject the proposition that an estimate of the return required on the market portfolio taken from an independent expert report in excess of the 10-year CGS yield is independent of the yield. The point estimate of the slope coefficient from a regression of an estimate of the return required on the market portfolio taken from an independent expert report in excess of the 10-year CGS yield on the CGS yield, though, is more than twice as large as its counterpart in Panel A. This reflects the size and timing of some of the adjustments made by the independent experts. Large upward adjustments, for example, were made to the initial estimates of the *MRP* provided in the Grant Samuel August

2012 report for Hastings Diversified Utilities Fund and the Grant Samuel October 2012 report for DUET at a time when GGS yields were low.

An estimate of the *MRP*, exclusive of a value assigned to imputation credits, relative to the 10-year CGS yield of 3.555 per cent for 21 February 2013 based on the first regression in Panel B of Table 4.1 is, in per cent per annum,

$$8.361 - 0.370 \times 3.555 = 7.046 \tag{9}$$

To summarise, regression analysis of the 132 independent expert reports suggests that an estimate of the *MRP* relative to the 10-year CGS yield for 21 February 2013 should lie between 6.62 and 7.05 per cent per annum exclusive of any value assigned to imputation credits.

The ACT in its recent decision found that the AER should place a value of 35 cents on each one dollar of imputation credits distributed.[105] 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.[106] 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[107]

$$0.35 \times 0.75 \times \left(\frac{0.30}{1 - 0.30} \right) = 0.1125 \tag{10}$$

The average dividend yield, measured as the ratio of dividends paid to start-of-year price, over the period 1883 to 2011, computed from the annual data that Brailsford, Handley and Maheswaran (2012) provide and that we update, is 5.12 per cent.[108] Thus an estimate of the value arising from the distribution of imputation credits based on this average yield in per cent per annum is

$$0.1125 \times 5.12 = 0.58 \tag{11}$$

The dividend yield, measured as the ratio of dividends paid to end-of-year price, for the S&P ASX All Ordinaries on 21 February 2013 is 4.1 per cent.[109] Using the AER assumption about the annual growth in dividends, this yield implies a value for the dividend yield,

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

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

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

[107] With a corporate tax rate of 28 per cent, which the government hopes to introduce at some stage in the future, the adjustment factor would be 1.1021. Using this lower corporate tax rate lowers the expected return to the market portfolio by around 5 basis points.

[108] 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.

[109] We compute the yield using the values of the daily accumulation and price indices for the All Ordinaries from 22 February 2012 to 21 February 2013.

measured as the ratio of dividends paid to start-of-year price, of $4.1 \times 1.06 = 4.35$ per cent. [110] Thus an estimate of the value arising from the distribution of imputation credits based on this yield in per cent per annum is [111]

$$0.1125 \times 4.35 = 0.49 \tag{12}$$

Using the lower of these two values, we conclude that regression analysis of the 132 independent expert reports suggests that an estimate of the *MRP* relative to the 10-year CGS yield for 21 February 2013 should lie between 7.11 and 7.53 per cent per annum inclusive of a value assigned to imputation credits.

4.4.3. Behaviour of independent expert assessments of the *MRP* in 2012

Figure 4.1 indicates that the views of independent experts have recently changed. A sensible alternative in the face of this recent change in behaviour is to estimate the *MRP* relative to the 10-year CGS yield not from a regression but as an average across reports using solely data from 2012. We again compute the *MRP* relative to the 10-year CGS yield as $MRP_{\text{IER}} + RFR_{\text{IER}} - RFR_{CGS}$.

The CGS yield averaged across the 17 days on which independent expert reports were released in 2012 is 3.44 per cent per annum while the risk-free rate chosen by the experts across these days was on average 3.93 per cent per annum. The *MRP* relative to the 10-year CGS yield averaged across the 17 independent expert reports published in 2012 lies between 6.75 and 7.43 per cent per annum exclusive of any value assigned to imputation credits. The lower bound is provided by the series of unadjusted values of the *MRP* while the upper bound is provided by the series of adjusted values. [112]

These results are not only economically but also statistically significant. Table 4.2 below provides:

- unadjusted estimates of the *MRP* – labelled 'unadjusted' – assessed by independent experts relative to the 10-year CGS yield over the period 2008-2011 and over 2012 exclusive of the value of imputation credits; and

- estimates that we adjust using the method we describe earlier in this section – labelled 'NERA adjusted' – that are also exclusive of imputation credits.

Both these sets of estimates are computed as averages across either the 115 reports from 2008 to 2011 or the 17 reports released in 2012. Tests of the null that there is no difference

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

[111]   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.

[112]   Thus an estimate of the return required on the market portfolio drawn for the expert reports is, on average across the 17 reports of 2012, 10.87 per cent per annum – only marginally higher than the figure of 10.7 per cent per annum that Ernst and Young (2012) report.

   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 5.

between the *MRP* relative to the 10-year CGS yield from 2008-2011 and the *MRP* relative to the 10-year CGS yield over 2012 easily reject the hypothesis. Tests of the null that the *MRP* relative to the 10-year CGS yield over 2012 is just 6 per cent, as the AER asserts is true of the *MRP inclusive* of credits, also overwhelmingly reject the hypothesis despite the fact that the experts measure the *MRP exclusive* of credits.

Table 4.2 also provides:

- estimates – labelled 'omitted' – of the *MRP* assessed by independent experts relative to the 10-year CGS yield on average over the period 2008-2011 and over 2012, exclusive of the value of imputation credits, that omit observations for which experts make adjustments; and

- estimates that we adjust using the method that Ernst and Young (2012) describe – labelled 'E & Y adjusted' – that are also exclusive of imputation credits. [113] Ernst and Young compute an adjusted value of the *MRP* under the implicit assumption that any difference between the final choice of a *WACC* and the initial value for the *WACC* is due solely to an adjustment to the risk-free rate.

The 'E & Y adjusted' estimates are computed as averages across either the 115 reports from 2008 to 2011 or the 17 reports released in 2012. The 'omitted' estimates are computed as averages across either the 109 reports from 2008 to 2011 or the 13 reports released in 2012 that do not make a significant adjustment. These two sets of estimates are also well above 6 per cent – even though they, like the other estimates, are *exclusive* of a value assigned to imputation credits. Thus the results that are produced:

- do not depend on whether the estimates of the *MRP* are adjusted or unadjusted;

- do not depend on how the adjustments are made; and

- do not depend on whether the observations that are adjusted are included or excluded from the analysis.

From (12), an estimate of the *MRP* relative to the 10-year CGS yield *inclusive* of a value assigned to imputation credits computed from the 17 independent expert reports published in 2012 lies between 7.32 and 8.00 per cent per annum. Recall that our regression-based estimates of the *MRP* relative to the 10-year CGS yield *inclusive* of a value assigned to imputation credits lie between 7.11 and 7.53 per cent per annum. Thus it is also clear that the results that we produce are not particularly sensitive to whether we use regression analysis or we use simple means computed from recent data.

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[113] 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 23.

Table 4.2
Analysis of independent expert assessments of the *MRP* relative to the 10-year CGS yield exclusive of imputation credits over time

Period or null hypothesis	Reports	Unadjusted	Omitted	NERA adjusted	E & Y adjusted
Panel A: Estimates					
2008 – 2011	115	6.350	6.356	6.375	6.394
		(0.041)	(0.043)	(0.044)	(0.050)
2012	17	6.752	6.949	7.426	7.217
		(0.119)	(0.101)	(0.375)	(0.212)
Panel B: Tests					
MRP(2008 – 2011) = MRP(2012)		3.197	5.398	2.787	3.789
		(0.005)	(0.000)	(0.013)	(0.001)
MRP(2012) = 6		6.315	9.380	3.807	5.752
		(0.000)	(0.000)	(0.002)	(0.000)

Note: Data are from the Connect-4 database and the RBA. Unadjusted indicates that the observations that experts adjust are unadjusted. Omitted indicates that the observations that experts adjust are omitted. In Panel A, estimates are outside of parentheses while standard errors are in parentheses. In Panel B, test statistics are outside of parentheses while p-values are in parentheses. To test the null that MRP(2008 – 2011) = MRP(2012), we use the Smith-Satterthwaite test described by Miller and Freund (1965). [114]

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

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

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

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

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

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

4.4.4. The cost of equity for the market in 2012

In section 4.4.3 we test hypotheses about the *MRP* in 2012 relative to earlier years and relative to the AER's views on the parameter. We find that independent experts have set a higher *MRP* on average in 2012 than they did over the four years from 2008 to 2011. We also find that experts have set a higher *MRP* on average in 2012 than the AER deems appropriate.

These results can be recast in terms of the cost of equity for the market, that is, the return required on the market. The cost of equity for the market is the sum of the 10-year CGS yield and the *MRP* relative to the 10-year CGS yield.

Exclusive of imputation credits, we find that the 'unadjusted' average cost of equity for the market that experts use in 2012 is 10.19 per cent per annum. Recall that our unadjusted estimate ignores the adjustments that four experts make to their initial choice of parameters in 2012. Not surprisingly, this figure is identical to the figure that Ernst and Young (2012) report in Appendix C of their report. [115]

There were four independent expert reports for which we adjusted the *MRP* using the methods described in section 4.4.1. Again, one rationale provided by experts for adjusting the *MRP* in 2012 was that risk premiums are at elevated levels. The 'NERA adjusted' average cost of equity for the market that experts use in 2012 is 10.87 per cent per annum.

Ernst and Young (2012) use a different method of adjusting the *MRP*. They assume that any adjustment that experts make reflects an adjustment to the risk-free rate that experts use. [116] We provide evidence that the experts use a risk-free rate in 2012 that exceeds on average the 10-year CGS yield. So the course of action that Ernst and Young pursue is a reasonable alternative to the course we pursue. The 'E & Y adjusted' average cost of equity for the market that experts use in 2012 is 10.66 per cent per annum. Again, not surprisingly, this figure is identical (to one decimal place) to the figure that Ernst and Young report in Appendix C of their report. [117]

Finally, if the four reports for 2012 in which experts adjust their initial choice of parameters are omitted we produce a similar estimate. The 'omitted' average cost of equity for the market that experts use in 2012 is 10.39 per cent per annum.

Hence, the conclusion to be drawn is that on any view of the data, during 2012, independent experts have been adopting a cost of equity for the market that is materially higher than that which is produced by applying the AER's method.

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[115] 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 23.

[116] 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 23.

[117] 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 23.

5.   Arithmetic versus Geometric Means

We emphasise in our March 2012 report that an estimate of the *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 regulated asset base (*RAB*) and to the evolution of prices – produce an unbiased estimate of the revenue that the market requires in any one year on the *RAB*. [118] We also emphasise 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 revenue that the market requires in any one year.

We show in our March 2012 report that the downward bias associated with an estimate of the *MRP* that uses the geometric mean can be substantial. [119] We provide estimates of the bias using simulations that employ data designed to have the same characteristics as the data that Brailsford, Handley and Maheswaran (2012) provide and that we update. [120] These simulations indicate that the downward bias associated with an estimate of the *MRP* over any single year that uses the geometric mean and data from 1883 through 2011 (1958 through 2011) is 134 (251) basis points.

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.

In independent advice provided at the AER's request, Lally (2012) reaches the same conclusion. [121] He states that: [122]

> '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.'

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

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

[120]   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.

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

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

In their December 2011 report, McKenzie and Partington recognise that 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. [123] They state, for example that:[124]

> 'The problem with the use of annual arithmetic averages, is that compounding an arithmetic average will lead to a bias.'

There is no sign in their December 2011 report, however, that McKenzie and Partington know whether or not the AER ever compounds an arithmetic average. In other words, while McKenzie and Partington recognise in their report that, in principle, compounding an arithmetic average can generate bias, they do not appear to know whether, in practice, the AER ever compounds an arithmetic average. They conclude their December 2011 analysis with the statement: [125]

> 'we recommend using the arithmetic average. This recommendation, however, is subject to the caveat that due recognition be given to the likely overestimation bias inherent in the use of the arithmetic average.'

Two months later in their February 2012 report, on the other hand, McKenzie and Partington (2012) state that:[126]

> 'We make it clear that the unbiased estimator of the MRP lies between the arithmetic average and the geometric average.'

> 'The evidence solidly supports the AER's position that over the ten year regulatory period the unbiased MRP lies somewhere between the arithmetic average and the geometric average of annual returns.'

The regulatory period is, of course, five years and not ten years. More importantly, the AER, as we stress in our March 2012 report and Lally (2012) makes clear, never – ignoring minor adjustments to the *RAB* and to the evolution of prices – compounds an arithmetic average. Thus an unbiased estimate of the *MRP* should place no weight on a geometric average.

The AER, though, argues in its *Multinet Draft Decision* that it does compound arithmetic averages. It states that: [127]

> '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

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[123]   McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011.

[124]   McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011, page 11.

[125]   McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011, page 12.

[126]   McKenzie, M. and G. Partington, *Report to the AER: Supplementary report on the equity market risk premium*, SIRCA Limited, 22 February 2012, pages 5-7.

[127]   AER, *Draft decision | Multinet 2013–17 | Draft decision appendices*, September 2012, page 30.

regulated assets. From this perspective, the AER considers an appropriate discount rate requires the evaluation of an expected multi-period cost of equity.'

For this reason, the AER dismisses the concerns that we raise in our March 2012 report. For example, the AER states in its *Roma to Brisbane Draft Decision* that: [128]

> 'while the issues are technical and complex, the AER considers NERA's concerns are no longer valid. 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.'

Given its own views and the conflicting advice provided by McKenzie and Partington (2011, 2012) and Lally (2012), the AER concludes that: [129]

> 'the consultants have different views, which need assessing to determine a reasonable approach. In view of the conflicting evidence, the AER considers it should review both arithmetic and geometric averages when considering the historical estimates of the MRP. It is aware of potential deficiencies with both averages, so does not exclusively rely on one or the other.'

We show here that use of the revenue equation, the asset-base roll-forward equation and an estimate of the *MRP* based on the arithmetic mean of a time series of excess returns to the market portfolio imply that, on average, the present value principle will be satisfied. We also show that use of the revenue equation, the asset-base roll-forward equation and an estimate of the *MRP* that places a positive weight on the geometric mean of a time series of excess returns to the market portfolio imply that, on average, the present value principle will be violated. Finally, 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*.

5.1. The Bias Produced by Compounding

While 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), the use of arithmetic means and the use of geometric means can provide biased estimates of unconditional expected multi-period returns. [130, 131] To see why the use of

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[128]   AER, *APT Petroleum Pipeline Pty Ltd Access arrangement draft decision Roma to Brisbane Pipeline 2012–13 to 2016–17*, April 2012, page 294.

[129]   AER, *Draft decision | Multinet 2013–17 | Draft decision appendices*, September 2012, page 30.

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

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

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

[130]   There are random variables which have no means. The mathematical expectation of a Cauchy random variable, for example, does not exist. We assume from henceforth that the expected values to which we refer exist.

[131]   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

arithmetic means can provide biased estimates of expected multi-period returns, it will be useful to consider a simple example. Define A to be the arithmetic mean of a sample of gross annual returns, that is, define:

$$A = \sum_{t=1}^{T} \frac{R(t)}{T}, \tag{13}$$

where

$R(t)$ = one plus the rate of return to some asset from t-1 to t; and

T = the number of observations.

If the return to the asset is serially uncorrelated, that is, if past returns are not useful for forecasting future returns, then the expected value of an estimate of the expected return to the asset over two years that uses the arithmetic mean will be:

$$E(A^2) = [E(A)]^2 + \text{Var}(A) = E(R(t)^2) + \text{Var}(A) > E(R(t)^2). \tag{14}$$

The bias associated with estimates of expected multi-period returns that use the arithmetic mean arises from the fact that the expectation of a function of a random variable will not in general equal the same function of the expectation of the variable. So in this simple example, the expectation of the square of the random variable does not equal, but exceeds the square of the expectation. [132] The key point that we wish to make, however, is that the AER, aside from some minor adjustments to the *RAB* and to the evolution of prices over the regulatory period, never uses the arithmetic mean of a sample of annual returns to estimate the expected value of a return over more than one year.

5.2. The AER Never Compounds

To see that the AER never compounds an estimate of the *MRP*, it will be helpful to understand how by use of the revenue condition the AER can ensure that the present value principle is, on average, satisfied.

The present value principle requires that:

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variable conditional on some other variable or variables. Our focus in this section of the report is on unconditional expectations.

[132] To see that 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, note that:

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

$$RAB(t) =$$

$$\sum_{s=1}^{5} \frac{\text{E}(REV(t+s)) - \text{E}(CAPEX(t+s)) - \text{E}(OPEX(t+s)) - \text{E}(TAX(t+s))}{(1+WACC)^s}$$

$$+ \frac{\text{E}(RAB(t+5))}{(1+WACC)^5} \, , \tag{15}$$

where

RAB(t)	=	the regulated asset base of the utility at the end of year *t*;
REV(t)	=	the utility's revenue in year *t*;
CAPEX(t)	=	capital expenditure in year *t*;
OPEX(t)	=	operating expenditure in year *t*;
TAX(t)	=	company tax paid in year *t*; and
WACC	=	the utility's *WACC* – a parameter unknown to the regulator.

Equation (14) states that the discounted value of the revenues that the *RAB* is expected to generate over the five years of the regulatory period plus the discounted value of the *RAB* five years from now must match the *RAB* today. Note that 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 expected value of the revenue that the AER allows a regulated utility each year is determined by the revenue equation:

$$\text{E}(REV(t+s)) = AERK \times \text{E}(RAB(t+s-1)) + \text{E}(DEP(t+s))$$

$$+ \text{E}(OPEX(t+s)) + \text{E}(TAX(t+s)) \, , \tag{16}$$

where

AERK	=	the value that the regulator chooses for the *WACC*; and
DEP(t)	=	depreciation in year *t*.

Unlike the true *WACC*, *AERK* is not a parameter but is instead an estimator. In other words, *AERK* is a random variable. Substitution of the revenue equation (16) into the present value condition (15) yields:

$$RAB(t) =$$

$$\sum_{s=1}^{5} \frac{AERK \times \mathrm{E}(RAB(t+s-1)) - \mathrm{E}(CAPEX(t+s)) + \mathrm{E}(DEP(t+s))}{(1+WACC)^s}$$

$$\frac{\mathrm{E}(RAB(t+5))}{(1+WACC)^5},$$

$$(17)$$

The asset-base roll-forward equation, however, states that:

$$RAB(t+s) = RAB(t+s-1) + CAPEX(t+s) - DEP(t+s)$$

$$(18)$$

Substitution of the asset-base roll-forward equation (18) into the present value condition (17) yields the condition:

$$(AERK - WACC) \sum_{s=1}^{5} \frac{\mathrm{E}(RAB(t+s-1))}{(1+WACC)^s} = 0$$

$$(19)$$

This condition will be satisfied only if the value for the *WACC* that the regulator chooses, *AERK*, matches the firm's *WACC*. The condition will be satisfied on average only if the value for the *WACC* that the regulator chooses, *AERK*, matches the firm's *WACC* on average, that is, only if:

$$\mathrm{E}(AERK) = WACC$$

$$(20)$$

This condition states that the value for the one-period *WACC* that the regulator chooses, *AERK*, 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.

6.   The Dividend Growth Model

6.1. Theory

A natural place to look for information on what the market thinks the *MRP* should be is in market prices. The DGM allows one, in principle, to use market prices together with forecasts of future dividends to compute the return that the market requires on an asset or portfolio. While one can observe market prices and forecasts of dividends over horizons of one or two years, few analysts forecast dividends at longer horizons. Thus as a practical matter, the use of the DGM requires that one make an assumption about the long-term growth of dividends.

Suppose that we assume, consistent with the analysis of Lally (2013), that consensus forecasts are available over two years and that expectations of dividends to be delivered more than two years hence are governed by the relation[133]

$$E(D(t+s)) = E(D(t+2))(1+g)^{s-2}, \qquad s > 2. \tag{21}$$

where

$D(t+s)$	=	the dividend the market portfolio pays at $t + s$.
g	=	long-run dividend growth.

With this assumption, we show in our March 2012 report that [134]

$$P(t) = \frac{E(D(t+1))}{1+E(R)} + \frac{E(D(t+2))}{1+E(R)}\left(\frac{1}{E(R)-g}\right). \tag{22}$$

where

$P(t)$ =   the price of a share in the market portfolio at t; and

$E(R)$ =   the internal rate of return that discounts back the expected future dividends that the market portfolio will pay back to the current price of a share in the market portfolio.

This expression can be solved for $E(R)$. Note that $E(R)$ is the internal rate of return that will discount back the market's expectations of the dividends that the market portfolio will pay in all future periods – not just over the next regulatory period – back to the current market value of the market portfolio. This internal rate of return will be a complicated average of the expected returns to the market portfolio over the next year and over all future years. As we point out in our March 2012 report and as Lally points out in his July 2012 and March 2013 reports, the internal rate of return $E(R)$ may lie above or below the current expected return to

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[133]   Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013, pages 16-20.

[134]   NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 42.

the market. [135] There are recently encountered circumstances, however, where it would have been difficult to argue persuasively that the current expected return sat below the return delivered by the DGM. In these circumstances the risk-free rate was low relative to its history but, contrary to the arguments put forward by Lally, it would have been difficult to argue that the current expected return sat below the return delivered by the DGM. In what follows we illustrate this point.

6.2. DGM Estimates

Our example uses data from September 2012. To be conservative, in the example we use consensus forecasts made in September 2012 to predict dividends per share (DPS) one and two years from that date and an estimate of real DPS growth over the past to predict DPS three or more years from September 2012. These predictions are conservative in that they use as a forecast of long-run nominal DPS growth a number, 5.65 per cent per annum, based on past real DPS growth and the RBA's target for inflation, lying below the forecast for long-run DPS growth that the AER uses in its *Aurora Draft Decision*, 6 per cent per annum. [136]

The AER bases its forecast of long-run DPS growth on GDP growth. Bernstein and Arnott (2002) note, though, that GDP growth is likely on average to exceed DPS growth. [137] They point out that: [138]

> 'per share earnings and dividends keep up with GDP only if no new shares are created. Entrepreneurial capitalism … creates a "dilution effect" through new enterprises and new stock in existing enterprises. So, per share earnings and dividends grow considerably slower than the economy.'

We, however, do not base our forecast of long-run DPS growth on GDP growth in this report, and nor do we do so in our March 2012 report. [139] In this report and in our March 2012 report we base our forecast simply on past real DPS growth and the RBA's target for inflation. A new issue of shares in an existing company or the replacement of an existing member of the All Ordinaries with another company will in general alter the market capitalisation of the All Ordinaries but will not alter the level of the All Ordinaries, that is, the value of a hypothetical share of the All Ordinaries. Thus, our use of past real DPS growth to forecast future DPS growth is entirely consistent with the way in which the DGM is developed from an identity that links the return on a single share over a single period to the price of the share at the start and end of the period and the dividends that the share pays at the end of the period.

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[135] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, page 3.

Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013, pages 5-9.

NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 42.

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

[137] Bernstein, W.J. and R.D. Arnott, *Earnings growth: The two percent dilution*, Financial Analysts Journal, 2003, pages 47-55.

[138] Bernstein, W.J. and R.D. Arnott, *Earnings growth: The two percent dilution*, Financial Analysts Journal, 2003, page 48.

[139] In our March 2012 report we do examine the relation between real DPS growth and real GDP growth and find that the two are related. We do not base our forecast of long-run DPS growth, though, on past real GDP growth.

We compute an estimate of the *MRP* using the DGM averaged across the 20 working days of September 2012. The DGM estimates of the return that the market required on the market portfolio that use Bloomberg consensus forecasts and our conservative estimate of long-run DPS growth indicate that, with an average 10-year bond yield of 3.13 per cent per annum in September 2012, an estimate of the *MRP* relative to the yield would have been be 8.03 per cent per annum. [140]

We note that this estimate lies below an estimate constructed using the assumption that the AER makes in its *Aurora Draft Decision* about the growth in dividends. [141] Using the AER's assumption, the *MRP* relative to a 10-year bond yield of 3.13 per cent per annum would have been 8.52 per cent per annum.

As we have emphasised, an estimate of the return that the market requires on an asset or portfolio that uses the DGM depends crucially on estimates of the long-run growth in dividends. One place to look for estimates of what the growth in dividends might be in the long-run is in the past behaviour of dividends.

Table 6.1 provides summary statistics for the real growth in DPS for the All Ordinaries from 1981 to 2011. We use data over this period because daily price and accumulation indices are available from 1980 onwards that allow one to accurately compute a DPS series for the index. We use the inflation data that Brailsford, Handley and Maheswaran (2012) provide and update their series using, like they do, the December year-end value of the CPI: All Groups Weighted Average of Eight Capital Cities series from the Australian Bureau of Statistics (ABS). [142]

Table 6.1 shows that the mean growth in real DPS has been around 3 per cent per annum over the period 1981 to 2011. The growth in real DPS has been volatile. As a result, a 95 per cent confidence interval for mean real DPS growth is from -1.30 to 7.44 per cent per annum. [143]

Table 6.1
Summary statistics for real DPS growth from 1981 to 2011

Variable	Mean	Standard deviation
Real DPS growth	3.07	12.41
	(2.23)	

Note: Data are from the ABS and Bloomberg. The standard error of the sample mean is parentheses.

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[140]   A risk-free rate of 3.135 per cent per annum is obtained by applying the AER's method of interpolation to compute the yield on a 10-year Commonwealth Government Security (CGS) over the 20-day averaging period from 3 September 2012 to 28 September 2012. The AER's method of interpolation is consistent with clause 6.5.2(d) of the National Electricity Rules.

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

[142]   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.

[143]   A tighter, but not dramatically tighter, 95 per cent confidence interval for mean real DPS growth can be constructed using the annual data that Brailsford, Handley and Maheswaran (2012) provide. Using their data, updated to 2011, we find that a 95 per cent confidence interval for mean real DPS growth lies from 0.26 to 4.84 per cent.

Figure 6.1 plots real DPS against time and consensus forecasts of DPS that Bloomberg provided in September 2012. [144] Consensus forecasts made on average during the 20 days from 3 September 2012 to 28 September 2012 appear in Table 6.2. The DPS forecasts are for the All Ordinaries and correspond to values of the All Ordinaries Price Index. Table 6.2 shows that the consensus in September 2012 was that dividends were expected to grow over the next two years by around 7 per cent per annum.

Using interpolation and the Bloomberg consensus forecasts that appear in Table 6.2 below, an estimate of the DPS for the All Ordinaries for the month of September 2013 would have been [145]

$$(288 \times 210.691 + 77 \times 226.276) \div 365 = 213.979 \tag{23}$$

and for the month of September 2014,

$$(288 \times 226.276 + 77 \times 243.265) \div 365 = 229.860. \tag{24}$$

Table 6.2
Bloomberg consensus forecasts of DPS

June 2013	June 2014	June 2015
210.691	226.276	243.265

Note: Data are from Bloomberg. The DPS forecasts are for the All Ordinaries and correspond to values of the All Ordinaries Price Index.

The ACT in its recent decision found that the AER should place a value of 35 cents on each one dollar of imputation credits distributed. [146] 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. [147] So to take into account the value of credits distributed, we multiply each DPS forecast by [148]

$$1 + 0.35 \times 0.75 \times \left(\frac{0.30}{1 - 0.30} \right) = 1.1125 \tag{25}$$

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[144] The consensus forecasts are extracted using the Bloomberg function EEO. Forecasts are made for the constituents of an index and the forecast for the index is a weighted average of the forecasts for each index member.

Bloomberg, *Getting started*, 2007.

[145] There are 31 days in July, 31 days in August and 15 days in the first half of September and so there are 77 days from the end of June until the middle of September..

[146] 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] ACompT 9, May 2011.

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

[148] With a corporate tax rate of 28 per cent, which the government hopes to introduce at some stage in the future, the adjustment factor would be 1.1021. Using this lower corporate tax rate lowers the expected return to the market portfolio by around 5 basis points.

Figure 6.1
Real dividends on the All Ordinaries
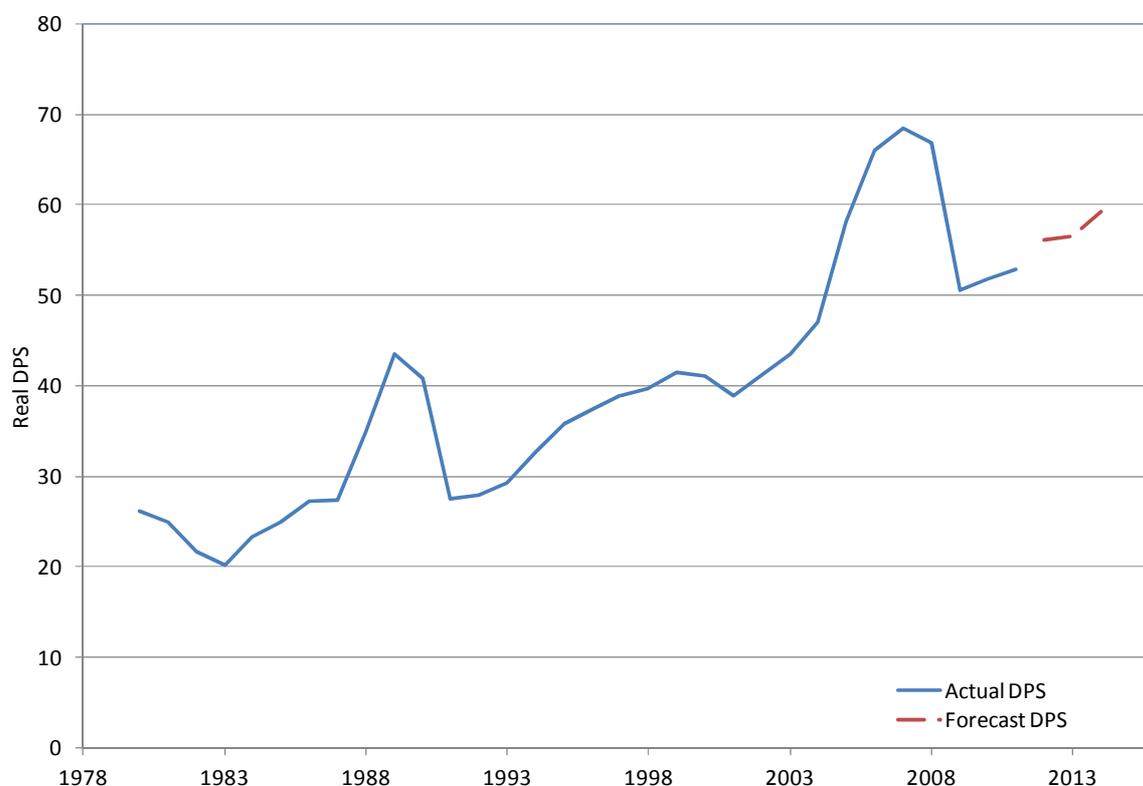
Note: Data are from the ABS and Bloomberg.

It is difficult to forecast the long-run growth in dividends. We fit a regime-switching model, in which there is a high-growth state and a low-growth state, to real DPS growth and find that the rate at which the model tends to move from one state to another is sufficiently fast that there is little point in using short-term consensus forecasts and estimates of past real DPS growth together to forecast long-run DPS growth. [149] So instead we assume that the expected long-run growth in real DPS equals the past growth in real DPS over the period 1981 to 2011 of 3.07 per cent per annum, although, as we have pointed out, the past growth is sufficiently volatile that it is difficult to determine with any degree of precision what is the mean growth in real DPS. We also assume that expected inflation lies at the middle of the RBA target range of 2 to 3 per cent, that is, it equals 2.5 per cent. [150] With these assumptions the expected long-run growth in dividends will be

$$100 \times ((1 + 0.0307) \times (1 + 0.0250) - 1) = 5.65 \text{ per cent.} \tag{26}$$

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[149] We fit a regime-switching model to real DPS growth because Hamilton (1989) finds that:

'The business cycle is better characterized by a recurrent pattern of [discrete] shifts between a recessionary state and a growth state than by positive coefficients at low lags in an autoregressive model.'

Hamilton, James D., *A new approach to the economic analysis of nonstationary time series and the business cycle*, Econometrica, 1989, pages 357-384.

[150] http://www.rba.gov.au/monetary-policy/about.html

Thus the assumption that we make about the long-run growth in dividends is conservative in the sense that we assume that it lies below the forecast for long-run DPS growth that the AER uses in its *Aurora Draft Decision*, 6 per cent per annum. [151]

The average level of the All Ordinaries Price Index over the 20 days from 3 September 2012 to 28 September 2012 was 4,382.068. So from (22), it follows that if we use the Bloomberg DPS forecasts, the expected return to the market portfolio as of September 2012, E(*R*), must satisfy

$$4,382.068 = \frac{213.979 \times 1.1125}{1 + \text{E}(R)} + \frac{229.860 \times 1.1125}{1 + \text{E}(R)} \left(\frac{1}{\text{E}(R) - 0.0565} \right). \tag{27}$$

The value of E(*R*) that satisfies (27) is 11.17 per cent per annum. Note that the value of E(*R*) that satisfies (27) is not the sum of a forecast of the one-year-ahead dividend yield and the long-term growth in dividends because (27) uses two forecasts of dividends rather than a single forecast.

A risk-free rate of 3.13 per cent per annum on an annual effective basis is obtained by applying the AER's method of interpolation to compute the yield on a 10-year CGS bond over the 20-day averaging period from 3 September 2012 to 28 September 2012. The DGM estimates of the return that the market would have required on the market portfolio that use the Bloomberg consensus forecasts indicate that with a 10-year bond yield of 3.13 per cent per annum an estimate of the *MRP*, relative to the yield, would have been 8.03 per cent per annum – rounded to two decimal places.

6.3. AER's DGM Estimates

The AER in its *Aurora Draft Decision* produces DGM estimates of the *MRP*. [152] The AER states that it bases these estimates on:

- a market value for a one-dollar imputation credit distributed of 35 cents;

- an assumed dividend growth rate of 6 per cent; and

- a dividend yield drawn from the RBA table f07.pdf. [153]

Imposing the assumption that

$$\text{E}(D(t + s)) = \text{E}(D(t))(1 + g)^s, \qquad s > 0 \tag{28}$$

yields the familiar form of the DGM:

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

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

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

$$E(R) = \frac{D(t+1)}{P(t)} + g = \frac{(1+g)D(t)}{P(t)} + g.$$

<div align="right">(29)</div>

Plugging in the numbers that the AER states that it uses and a yield for September 2012 of 4.8 per cent per annum from the RBA document f07.pdf and grossing up the yield for the assumed value of imputation credits distributed using (25) produces an estimate of the return to the market of [154]

$$E(R) = 100 \times ((1 + 0.06) \times 1.1125 \times 0.048 + 0.06) = 11.66 \text{ per cent}$$

<div align="right">(30)</div>

This estimate is 49 basis points higher than the estimate that we construct using Bloomberg consensus forecasts.

6.4.   Interpreting DGM Estimates of the Expected Return to the Market

As we point out in our March 2012 report and Lally points out in his July 2012 and March 2013 reports, the DGM delivers the single internal rate of return that discounts forecasts of the future dividends that the market portfolio will pay back to the current value of the market portfolio. This internal rate of return will be a complicated average of the expected returns to the market portfolio over the next year and over all future years and may lie above or below the current expected return to the market. [155]

To illustrate the problems that one may face in interpreting the single internal rate of return that the DGM delivers, Lally (2012) provides an example in which one may be misled by the DGM into overestimating the short-term cost of equity and *MRP*. [156] Lally assumes that the one-year risk-free rate, the annual equity premium and the annual cost of equity follow the paths shown in Figure 6.2. Lally assumes in the example that the one-year risk-free rate is currently low, 3.8 per cent per annum, but will be expected to rise to its long-run value of 6 per cent per annum after 10 years. He assumes, on the other hand, that the equity premium is currently 6.2 per cent per annum, marginally above its long-run value of 6 per cent per annum to which it is expected to fall after 10 years. These figures imply that the annual market cost of equity is currently 10 per cent and will be expected to rise to its long-run value of 12 per cent after 10 years.

Lally assumes that the dividends delivered by a share will grow at a rate of 5 per cent per annum in perpetuity. Discounting the market's expectations of the stream of future dividends that a share will generate using the term structure of required returns on equity will allow one

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

[155]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 15-16.

Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013, pages 5-9.

NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 42.

[156]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 15-16.

to compute the current share price. Lally computes this price and then using the price shows that the single internal rate of return that the DGM will deliver will be 11.1 per cent per annum. Combining this value with the assumed current risk-free rate of 3.8 per cent could lead one to believe, incorrectly, that the equity premium is currently 11.1 – 3.8 = 7.3 per cent – well above its long-run mean – when it is really 6.2 per cent – above its long-run mean, but only marginally so.

While Lally's example shows that one can, in principle, be misled in relying on estimates of the current *MRP* generated by the DGM, it does not follow that one will necessarily be misled – even if the risk-free rate is substantially below its long-run mean..

Figure 6.2
Lally's (2012) example
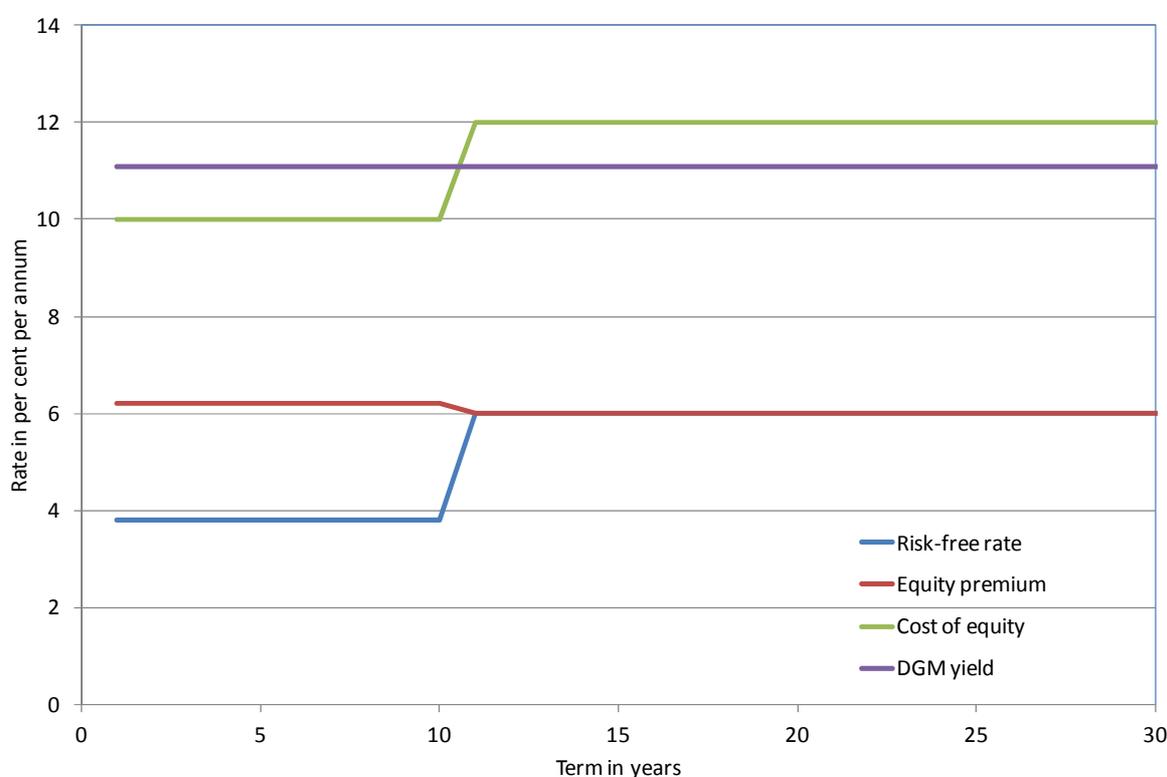
Our estimate of the mean return to the market portfolio based on consensus forecasts of dividend growth for the two years from September 2012 and a conservative estimate of dividend growth thereafter is 11.17 per cent per annum inclusive of credits. If expected inflation as of September 2012 lay at the middle of the RBA target range of 2 to 3 per cent, that is, at 2.5 per cent, then this estimate corresponds approximately to an estimate of the mean real return to the market portfolio in per cent per annum of:[157]

$$100 \times \left(\left(\frac{1+0.1117}{1+0.0250} \right) - 1 \right) = 8.46 \tag{31}$$

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[157]   http://www.rba.gov.au/monetary-policy/about.html

An estimate of the mean return to the market portfolio based on the AER's assumptions is 11.66 per cent per annum inclusive of credits. [158] If expected inflation as of September 2012 lay at the middle of the RBA target range of 2 to 3 per cent, an estimate that uses the AER's assumptions corresponds approximately to an estimate of the mean real return to the market portfolio in per cent per annum of:[159]

$$100 \times \left(\left(\frac{1 + 0.1166}{1 + 0.0250} \right) - 1 \right) = 8.94 \tag{32}$$

An estimate of the long-run mean real return to the market portfolio over the period 1883 to 2011, computed from the annual data that Brailsford, Handley and Maheswaran (2012) provide and that we update, is 8.48 per cent per annum, inclusive of credits. [160] Thus an estimate of the mean real return to the market portfolio as of September 2012 generated by the DGM is almost identical to or higher than an estimate of the long-run mean of the real return. This, as we will show, implies that it would have been difficult to generate a reasonable empirical argument corresponding to the theoretical argument that Lally (2012) provides to justify a low *MRP* for the five years from September 2012. [161]

Using the AER's assumption that the *MRP* is 6 per cent per annum, a 10-year CGS yield of 3.13 per cent for the period 3 September to 28 September 2012 and an assumption that expected inflation as of September 2012 lay at the middle of the RBA target range of 2 to 3 per cent produces an estimate of the mean real return to the market in per cent per annum of: [162]

$$100 \times \left(\left(\frac{1 + 0.0913}{1 + 0.0250} \right) - 1 \right) = 6.47 \tag{33}$$

To determine whether there are term structures for the mean real return to the market portfolio as of September 2012 that would have simultaneously satisfied the following conditions:

(i) a five-year mean real return to the market of 6.47 per cent per annum – consistent with the AER's assumption of an *MRP* of 6 per cent per annum;

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

[159] http://www.rba.gov.au/monetary-policy/about.html

[160] The ACT in its recent decision found that the AER should place a value of 35 cents on each one dollar of imputation credits distributed and so we assume that each dollar of credits distributed is worth 35 cents.

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

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.

[161] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 15-16.

[162] AER, *Draft Distribution Determination Aurora Energy Pty Ltd 2012–13 to 2016–17*, November 2011, page 39.

http://www.rba.gov.au/monetary-policy/about.html

(ii)   a with-credit yield for September 2012 of 1.1125 × 4.8 = 5.34 per cent – drawn from the same source that the AER uses; [163]

(iii) an expected growth in real dividends of 3.41 per cent – consistent with the AER's assumption about the future growth in dividends; [164] and

(iv)   a long-run mean real return to the market portfolio of 8.48 per cent per annum – estimated from the annual data on which the AER in large part relies, [165]

we search across term structures that belong to the Nelson-Siegel family of curves: [166]

$$R(t) = a + b\exp(-t/\tau) + c\,(t/\tau)\exp(-t/\tau) \; , \tag{34}$$

where $R(t)$ is the mean real return to the market portfolio from year t-1 to year t and a, b, c and τ are parameters. We use this family of curves instead of the step function that Lally employs because empirically the Nelson-Siegel family of curves has been found to contain many of the term structures that one encounters in practice and one rarely encounters in practice a term structure that is a step function.

To search for term structures for the mean real return to the market portfolio that would satisfy (i) to (iv) we start by assuming that $a = 0.0848$, $b = c = 0$ and $\tau = 25$. These parameter values imply that the term structure is flat and the mean real return to the market is 8.48 per cent per annum. Thus condition (iv) will be satisfied. We assume that the dividend paid in year 1 is \$1.0341. It follows that if dividend growth is 3.41 per cent per annum, consistent with condition (iii), the dollar price of a share in the market will be

$$\frac{1 + 0.0341}{0.0848 - 0.0341} = 20.396 \tag{35}$$

Condition (ii), however, states that the dollar price of a share in the market must be

$$\frac{1}{0.0534} = 18.727 \tag{36}$$

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[163]   The without-credit dividend yield of 4.8 per cent, measured as the ratio of the dividends paid over a year to the end-of-year price, is taken from the RBA's document f07.pdf.

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

[164]   The expected growth in real dividends corresponding to an expected nominal growth of 6 per cent per annum will be $100 \times ((1.060/1.025) - 1) = 3.41$ per cent per annum where we assume that expected inflation sits in the middle of the RBA's target range.

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

http://www.rba.gov.au/monetary-policy/about.html

[165]   AER, *Draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

[166]   Equation (34) corresponds to equation (1) on page 475 of

Nelson, C.R. and A.F. Siegel, *Parsimonious modelling of yield curves*, Journal of Business, 1987, 473-489

Thus the term structure that we have selected will violate condition (ii). It is straightforward to see that it will also violate condition (i). The five-year mean real return to the market associated with the term structure is 8.48 per cent rather than the 6.47 per cent that condition (i) dictates that it should be. Since conditions (i) and (ii) are violated we use Solver in Excel to search for values for a, b, c and τ that will satisfy these conditions as well as conditions (iii) and (iv).

Figure 6.3 provides an example of a term structure, labelled Example 1 in the figure, which would simultaneously satisfy conditions (i) to (iv). The mean real returns are mean one-year real returns – like the mean one-year real returns in Figure 6.2. Consistent with what intuition would indicate would need to be true, the term structure is hump-shaped, first rising and then falling. Condition (iv) that the future long-run mean real return to the market portfolio must match an estimate that uses past data pins down long-term expectations. Condition (i) that dictates that the short-term mean real return to the market portfolio must be below the long-run mean restricts short-term expectations to be below their long-term counterparts. Lastly, conditions (ii) and (iii) together imply that the single internal rate of return delivered by the DGM must come close to matching the long-run mean real return to the market. Thus together these conditions imply that, between the short term and the long term, expectations of the real return to the market portfolio must lie above their long-term counterparts.

Figure 6.3 also provides an example of a term structure, labelled Example 2 in the figure, which relaxes the restriction that the long-run mean real return to the market portfolio must match an estimate produced from the annual data on which the AER in part relies. Relaxing this assumption implies that the term structure no longer need be hump-shaped. For the term structure not to be hump-shaped, however, while simultaneously delivering conditions (i) to (iii), requires that the long-run mean real return to the market portfolio lie above the estimate of the mean of 8.48 per cent per annum produced using the annual data on which the AER in large part relies. [167] In Example 2, the long-run mean real return is 11 per cent per annum – substantially above the estimate of 8.48 per cent per annum produced using past data.

We do not pretend that the two examples that we provide are the only examples that would generate a low mean real return over the five years from September 2012, but common sense dictates that other examples would have to share the same sort of characteristics.

To justify a low mean real short-term return to the market portfolio when the DGM delivers a mean real return that comes close to matching an estimate of the long-run mean real return produced from past data would require that either:

• the term structure of mean real returns to the market portfolio be hump-shaped, with returns first rising then falling; or

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[167]   AER, *Draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

- the long-run mean real return to the market portfolio lie above the estimate of the mean of 8.48 per cent per annum produced using the annual data on which the AER in large part relies; [168] or

- a significantly lower rate of growth in dividends.

We know of no data available as of September 2012 to suggest that any of these conditions were satisfied.

Figure 6.3
Examples of term structures that would support the AER's view
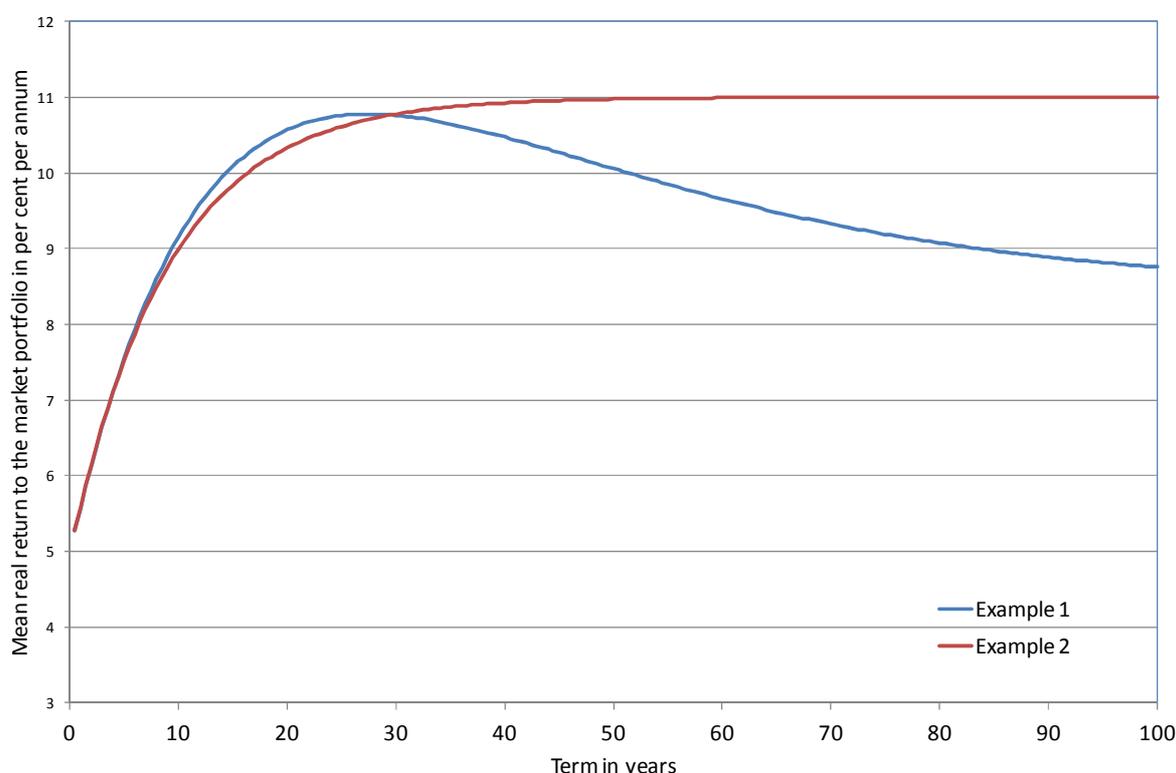
Evidence on the market's expectations of future CGS rates as of September 2012 is, on the other hand, available. Figure 3.4 plots CGS zero-coupon rates and six-month forward rates against term to maturity using data from the RBA for September 2012. The figure plots RBA zero-coupon rates for bonds with maturities of up to 10 years, zero-coupon rates that we have independently derived from yields provided by the RBA in the workbook f16.xls, a zero-coupon curve fitted to our zero-coupon rates belonging to the Nelson-Siegel family: [169, 170]

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[168]   AER, *Draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

[169]   www.rba.gov.au/statistics/tables/xls/zcr-analytical-series.xls

[170]   Equation (37) corresponds to equation (2) on page 475 of

    Nelson, C.R. and A.F. Siegel, Parsimonious modelling of yield curves, Journal of Business, 1987, 473-489.

$$S(t) = a + b[1 - \exp(-t/\tau)]/(t/\tau) + c \exp(-t/\tau) , \qquad (37)$$

where $S(t)$ is the t-year zero-coupon rate and six-month forward rates, computed as annual effective rates, derived from the curve.

While in the past forward rates have provided a poor guide to the market's expectation of future spot rates, Wright (2011) finds that the gap between forward rates and expectations of future spot rates has narrowed.[171] He shows that term premiums in Australia, among other countries, constructed using survey data on expectations of future spot rates have declined from around four per cent per annum to around one per cent. Thus while forward rates may not match the market's expectations of future spot rates, they can provide a guide.

Using the six-month forward rates as a guide, one must conclude that Figure 6.4 provides no evidence of the hump, characterised by rates first rising and then falling, that would have supported a low mean real short-term return to the market portfolio consistent with the AER's views of the market.

Figure 6.4
Term structure of forward and spot rates on average during September 2012
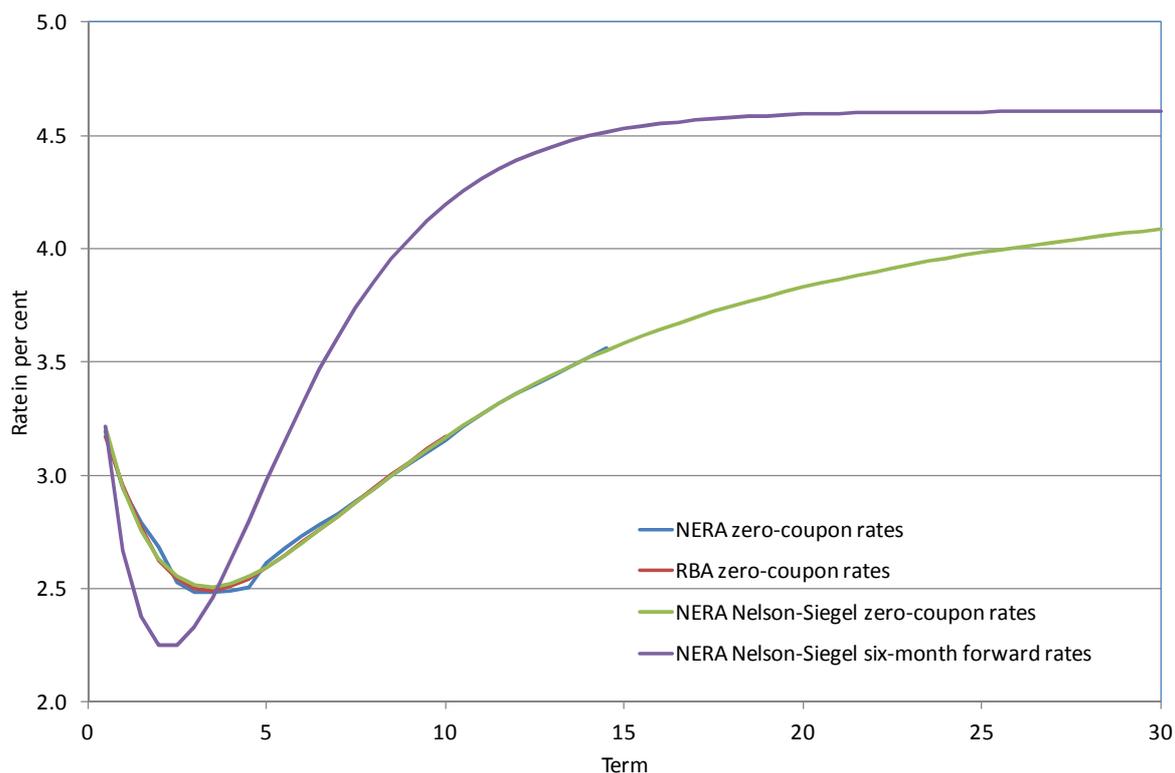
6.5. Summary

To summarise, an estimate of the mean real return to the market portfolio generated by the DGM as of September 2012 is almost identical to or higher than an estimate of the long-run mean of the real return. This implies that it would have been difficult to generate a reasonable empirical argument corresponding to the theoretical argument that Lally (2012) provides to justify a low *MRP* for the five years from September 2012. [172]

We show that for one to have extracted from the DGM in September 2012 an estimate of the mean real return to the market that would have matched an estimate of the long-run mean of the real return constructed from past data and for one to have simultaneously observed:

(i)   a five-year mean real return to the market of 6.47 per cent per annum – consistent with the AER's assumption of an *MRP* of 6 per cent per annum;

(ii)   a with-credit yield of 1.1125 × 4.8 = 5.34 per cent – drawn from the same source that the AER uses; [173]

(iii) an expected growth in real dividends of 3.41 per cent – consistent with the AER's assumption about the future growth in dividends; [174] and

(iv)   a long-run mean real return to the market portfolio of 8.48 per cent per annum – estimated from the annual data on which the AER in large part relies, [175]

would have required either that:

- the term structure of mean real returns to the market portfolio to have been hump-shaped, with returns first rising and then falling; or

- the long-run mean real return to the market portfolio to have sat above the estimate of the mean of 8.48 per cent per annum produced using the annual data on which the AER in large part relies; [176] or

- a significantly lower rate of growth in dividends.

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[172]   Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 15-16.

[173]   The without-credit dividend yield of 4.8 per cent, measured as the ratio of the dividends paid over a year to the end-of-year price, is taken from the RBA's document f07.pdf.

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

[174]   The expected growth in real dividends corresponding to an expected nominal growth of 6 per cent per annum will be $100 \times ((1.060/1.025) - 1) = 3.41$ per cent per annum where we assume that expected inflation sits in the middle of the RBA's target range.

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

   http://www.rba.gov.au/monetary-policy/about.html

[175]   AER, *Draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

[176]   AER, *Draft decision Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013–17 Part 1*, September 2012, page 94.

We know of no data available as of September 2012 to suggest that any of these conditions were satisfied.

7.   Conclusions

This report has been prepared for Multinet Gas by NERA Economic Consulting (NERA). Multinet Gas has asked NERA to examine a number of issues that arise from recent decisions and reports published by the Australian Energy Regulator (AER), the Queensland Competition Authority (QCA) and advisors to the two regulators.

In particular, Multinet Gas has asked NERA to assess:

1. The theoretical rationale for and empirical evidence on the relation between:

    •   the cost of equity and the equity beta of a firm; and

    •   the market risk premium (*MRP*) and the volatility of the market portfolio,

    and what impact a consistent use of the empirical evidence will have on the value for the cost of equity that one computes;

2. Whether the use of 'Siegel averaging' will produce unbiased estimates of the long-run *MRP*;

3. Whether current market practitioner estimates of the return required on the market are consistent with a constant *MRP* through time when measured against the prevailing yield on 10-year Commonwealth Government Securities (CGS), and whether the estimates are consistent with a prevailing forward looking *MRP* of 6 per cent;

4. To the extent that an historical estimate of the *MRP* is relevant, whether an historical estimate of the *MRP* should be computed using an arithmetic mean, geometric mean, or some weighted average of the two.

5. Whether the dividend growth model (DGM) will necessarily deliver an upwardly biased estimate of the *MRP* for the next regulatory period when the risk-free rate is low.

This report addresses each of these questions in turn.

1. Consistent use of evidence

In its recently published *Access arrangement draft decision, Multinet Gas (DB No. 1) Pty Ltd Multinet Gas (DB No. 2) Pty Ltd 2013-17* (the AER's *Draft Decision*)), the AER considers two distinct issues relating to the CAPM:

•   whether to use the SL CAPM or Black CAPM to set the cost of equity; and

•   whether to use an intertemporal version of the SL CAPM or other methods to set the *MRP*.

In considering these issues a regulator must decide whether to use a theoretical model, the SL CAPM, in which it may have a strong belief or the evidence that in general rejects the model. A decision that relied solely on a belief in the SL CAPM:

•   would use the SL CAPM to set the cost of equity; and

- would use an intertemporal version of the SL CAPM and an estimate of the volatility of the return to the market portfolio to set the *MRP*. [177]

In contrast, a decision that relied solely on the empirical evidence:

- would conclude that there is no evidence of a link between the cost of equity and the equity beta of a firm and so, if limited to the use of the equity beta of a firm to measure risk, would use the Black CAPM to set the cost of equity;[178, 179] and

- would conclude that there is no evidence of a link between the *MRP* and the volatility of the return to the market portfolio and so would use other methods to set the *MRP*. [180]

Notwithstanding that there is no evidence of a link between the cost of equity and the equity beta of a firm or between the *MRP* and the volatility of the return to the market portfolio, the AER's *Draft Decision* is selective in its reliance on either theory or evidence. Specifically, the AER ignores the evidence against the SL CAPM's ability to predict the returns required on assets and uses the model to set the cost of equity, but rejects the use of an intertemporal version of the SL CAPM to set the *MRP* because of the evidence against the model.

As a result of the selective use of theory and empirical evidence, the AER's *Draft Decision* implicitly asserts that:

- at each point in time an investor will seek an additional return for investing in an asset with a high beta – because of the impact that investing in a high-beta stock will have on the risk of the investor's overall portfolio – that is, the market portfolio; but

- an investor will not seek an additional return for investing in the market portfolio when the risk of the market portfolio is high and will not accept a lower return for investing in the market portfolio when the risk of the market portfolio is low.

To be consistent, the AER must either choose to rely on *all* of the empirical evidence before it or use *none* of the evidence – employing instead its prior belief in the theory underpinning the SL CAPM. Our preference is that when confronted with a divergence between theory and empirical evidence, greater weight should be placed on empirical evidence.

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[177]   Merton (1973) provides conditions under which an intertemporal version of the SL CAPM will hold.

    Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica, 1973, pages 867-887.

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

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

[179]   Grundy (2010) reviews the empirical evidence on the SL CAPM and states:

    'I know of no published study that has empirically tested the Sharpe CAPM and failed to reject the Sharpe CAPM.'

    Grundy, B., *The calculation of the cost of capital: A report for Envestra*, University of Melbourne, 30 September 2010, page 10.

[180]   McKenzie, M. and G. Partington, *Review of regime switching framework and critique of survey evidence*, SIRCA Limited, 7 September 2012.

2. Siegel Averaging

Lally (2012) argues, on the basis of evidence that Siegel (1992) provides, that the sample mean of a series of returns to the market portfolio in excess of the yield on a government bond can be an upwardly biased estimate of the long-run *MRP*. [181] Lally's argument is based on a view that:

- investors have systematically underestimated inflation; and that

- while the real returns to stocks are, in the long run, protected against unanticipated inflation, the real returns to bonds are not protected against unanticipated inflation.

Lally argues that while investors have in the past underestimated inflation, they will not do so in the future. As a result, he argues that:

- while the real return to the market portfolio in the future will on average be similar to its real return in the past;

- the real return to a government bond in the future will on average be higher than it has been in the past.

So Lally argues that an unbiased estimate of the long-run *MRP* going forward will be lower than the sample mean, computed from past data, of a series of returns to the market portfolio in excess of a government bond yield.

We show here that Lally's argument makes little sense because the available evidence does not support the idea that those whose business it is to forecast inflation – that is, professional forecasters – systematically underestimate inflation. We identify periods over which forecasters have underestimated inflation but these are matched by periods over which forecasters have overestimated inflation. So it is difficult to see how the sample mean of a series of returns to the market portfolio in excess of the yield on a government bond can be viewed as an upwardly biased estimate of the long-run *MRP*.

The QCA (2012) uses Lally's suggestion and computes and estimate of the long-run *MRP* for Australia of 4.32 per cent per annum. [182] The QCA arrives at this figure by subtracting the difference between what it deems to be the long-run real yield, 4 per cent, and the average real holding-period return from 1900 to 2000 of 1.9 per cent that Dimson, Marsh and Staunton (2002) report from an estimate of the with-imputation-credit *MRP* taken from Brailsford, Handley and Maheswaran (2012) of 6.21 per cent per annum. [183] Clearly, the QCA has made an arithmetical error and has instead subtracted the long-run real yield of 1.9 per cent from the with-imputation-credit *MRP* of 6.21 per cent per annum. Regardless of

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[181] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, pages 28-29.

[182] QCA, The risk-free rate and the market risk premium, November 2012, page 11.

[183] 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.

Dimson, E., P. Marsh, and M. Staunton, *Triumph of the Optimists*, Princeton University Press: Princeton, New Jersey, United States, 2002.

how the QCA arrived at the figure, however, the QCA assumes that investors have underestimated inflation by around two per cent each year over the 128-year period from 1883 to 2010. The evidence that we provide suggests that this assumption is not credible.

3. Market practitioner estimates

Independent expert reports potentially provide an alternative source of information on the value for the *MRP* used by market participants. The use of independent expert reports circumvents a number of the problems associated with other forms of market data such as 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 how returns are measured, that is, whether returns are continuously compounded or not continuously compounded;

- 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.

We examine 132 independent expert reports conducted between 2008 and 2012 and find evidence of a significant negative relation between the 10-year CGS yield and the *MRP* that experts choose relative to the yield. From this relation we estimate that the *MRP* relative to the CGS yield for 21 February 2013 of 3.55 per cent per annum should lie between 7.11 and 7.53 per cent per annum inclusive of a value assigned to imputation credits. Separately we estimate that the *MRP* relative to the 10-year CGS yield computed from the 17 independent expert reports published in 2012 lies between 7.32 and 8.00 per cent per annum, inclusive of a value assigned to imputation credits.

Further, statistical tests that we conduct show that an *MRP* of 6 per cent is inconsistent with the *MRP* (relative to the 10-year CGS yield over 2012) contained in the 17 independent expert reports published in 2012.

4. Estimating the historical *MRP*

In the *Draft Decision* the AER states its belief that consideration should be given to estimates of the *MRP* based on both arithmetic and geometric averages. Whether an arithmetic or geometric average is appropriate will depend on whether there is any compounding of estimates of the *MRP* in the regulatory process.

- In the absence of compounding an arithmetic average should be used since the use of a geometric average will produce a downwardly biased estimate of the *WACC*.

- On the other hand, if regulatory returns are compounded, then some weight should be placed on a geometric average since an arithmetic average used alone will produce an upwardly biased estimate of the *WACC*.

We show that, aside from some minor adjustments to the regulatory asset base (*RAB*) and to the evolution of prices over the regulatory period, the AER *never* compounds the *WACC* over more than one year. As a result, the use of an arithmetic average will produce an *unbiased* estimate of the revenue that the market requires in any one year on the *RAB*. In contrast, an estimate of the *WACC* that is in part based on a geometric average of the *MRP* will produce a *downwardly biased* estimate of the revenue that the market requires in any one year.

5. The *DGM*

A natural place to look for information on what the market thinks the *MRP* should be is in market prices. The DGM allows one, in principle, to use market prices together with forecasts of future dividends to be distributed by the market portfolio to compute the return that the market requires on the portfolio. The return that the DGM delivers, though, is the single internal rate of return that will discount back the market's expectations of the dividends that the market portfolio will pay in all future periods – not just over the next regulatory period – back to the current market value of the market portfolio. This internal rate of return will be a complicated average of the expected returns to the market portfolio over the next year and over all future years.

As we point out in our March 2012 report and Lally points out in his July 2012 and March 2013 reports, the internal rate of return that the DGM delivers may lie above or below the current expected return to the market. [184] Nevertheless, we show that there are recently encountered circumstances where it would have been difficult to argue persuasively that the expected return over the next regulatory period sat below the return delivered by the DGM. In these circumstances the risk-free rate was low relative to its history but, contrary to the arguments put forward by Lally, it would have been difficult to argue that the expected return to the market portfolio over the next regulatory period sat below the return delivered by the DGM.

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[184] Lally, M., *The cost of equity and the market risk premium*, Victoria University of Wellington, 25 July 2012, page 3.

Lally, M., *The dividend growth model*, Victoria University of Wellington, 4 March 2013, pages 5-9.

NERA, *Prevailing conditions and the market risk premium: A report for APA Group, Envestra, Multinet & SP AusNet*, March 2012, page 42.

Appendix A.   Other Miscellaneous Issues

In this appendix we examine other miscellaneous issues arising from recent reports that the AER has commissioned.

A.1. Means, Medians and Modes

McKenzie and Partington (2011), in work commissioned by the AER, consider the very basic question of what statistic one should use to estimate the *MRP*. [192] McKenzie and Partington state that: [193]

>'Empirical estimation of the market risk premium commonly results in a distribution of possible risk premiums, or returns. So a natural question is which measure of the central tendency of the distribution should be used - the mean, median, or mode. There is no compelling reason to assert the superiority of one measure over another. Common practice has been to use the mean, in part because it is the most mathematically tractable measure. As a consequence, where the returns are skewed, the MRP estimate will be biased relative to the other two possible measures. This can be a particular problem in small samples where the mean can be strongly influenced by one or two extreme observations. Where large samples are used, we anticipate that differences between the three measures of central tendency be small.'

There are a number of problems with this statement. First, the statement that 'there is no compelling reason to assert the superiority of one measure over another' is incorrect. The SL CAPM and other pricing models such as the Fama-French three-factor model define the *MRP* to be the difference between the expected return to the market portfolio and the risk-free rate. This suggests that a desirable characteristic of an estimator for the *MRP* is that it be an unbiased estimator for the difference between the expected return to the market portfolio and the risk-free rate. The sample mean of a series of returns to the market portfolio in excess of the risk-free rate will provide an unbiased estimator for the difference, so long as the *MRP* exists, but, as we will show below, the median need not provide an unbiased estimator. [194]

Second, the statement that 'where the returns are skewed the [sample mean] will be biased' is also incorrect as we will also show below.

Third, the statement that in 'large samples … differences between the three measures of central tendency [will] be small' is incorrect too as we will also indeed show.

The simplest way to demonstrate that the assertions that McKenzie and Partington make are incorrect is through a numerical example. Let the gross return to the market portfolio be lognormally distributed and let the risk-free rate be a constant through time. Then the distribution of returns to the market portfolio will be positively skewed and the distribution of

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[192]   McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011.

[193]   McKenzie, M. and G. Partington, *Report to Corrs Chambers Westgarth: Equity market risk premium*, 21 December 2011, page 5.

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

returns to the market portfolio in excess of the risk-free rate will also be positively skewed. Since we assume that the risk-free rate is a constant, we can in what follows ignore the risk-free rate and focus solely on the problem of estimating the mean return to the market portfolio.

We assume that the continuously compounded annual return to the market portfolio is normally distributed with mean 8 per cent and standard deviation 20 per cent. This implies that the not continuously compounded gross return is lognormal with mean 1.10517 and standard deviation 0.22326. [195] The median of the distribution of not continuously compounded gross returns will be $\exp(0.08) = 1.08329$. [196] To examine the behaviour of the sample mean and sample median of samples of the simple returns corresponding to these gross returns, we conduct simulations. Each simulation uses 100,000 replications and we conduct separate simulations for each of four different sample sizes. The results of the simulations appear in Table A.1 below. The table shows that:

- even though the distribution of simple returns is skewed to the right, the mean of a sample of simple returns is an unbiased estimator for the population mean;

- the median need not provide an unbiased estimator for the population mean; and

- differences between the expected values of the sample mean and sample median do not disappear as the sample size increases.

Table A.1
The mean and median of a sample drawn from a lognormal distribution

Sample Size	25	50	100	200
Mean	10.507	10.522	10.524	10.516
Median	8.450	8.397	8.382	8.359

Note: The table shows the average sample mean and sample median simple rate of return in per cent across 100,000 replications. The underlying distribution of the gross simple return is lognormal with mean 1.10517 and standard deviation 0.22326.

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[195] Note that if $x \sim N(\mu, \sigma^2)$, then $E(\exp(x) - 1) = \exp(\mu + 0.5\sigma^2) - 1$ and $Var(\exp(x) - 1) = \exp(2\mu)(\exp(2\sigma^2) - \exp(\sigma^2))$, where Var(.) denotes the variance operator. See, for example,

http://mathworld.wolfram.com/LogNormalDistribution.html

[196] Note that if $x \sim N(\mu, \sigma^2)$, then the median of x will be μ. It follows that the median of $\exp(x)$ will be $\exp(\mu)$.

Appendix B.   Curricula Vitae

Simon M. Wheatley

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

Overview

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

Personal

   Nationalities: U.K. and U.S.

   Permanent residency: Australia

Employment

- Special Consultant, NERA Economic Consulting, 2009-present

- External Consultant, NERA Economic Consulting, 2008-2009

- Quantitative Analyst, Victorian Funds Management Corporation, 2008-2009

- Adjunct, Melbourne Business School, 2008

- Professor, Department of Finance, University of Melbourne, 2001-2008

- Associate Professor, Department of Finance, University of Melbourne, 1999-2001

- Associate Professor, Australian Graduate School of Management, 1994-1999

- Visiting Assistant Professor, Graduate School of Business, University of Chicago, 1993-
  1994

- Visiting Assistant Professor, Faculty of Commerce, University of British Columbia, 1986

- Assistant Professor, Graduate School of Business, University of Washington, 1984-1993

Education

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

- M.A., Economics, Simon Fraser University, Canada, 1979

- M.A., Economics, Aberdeen University, Scotland, 1977

Publicly Available Reports

Prevailing Conditions and the Market Risk Premium: A report for APA Group, Envestra, Multinet & SP AusNet, March 2012, http://www.aer.gov.au/content/item.phtml?itemId=753605&nodeId=418ee68d5b881d585 15e4f39d9d3aee3&fn=G-5%20NERA%20%20Prevailing%20Conditions%20and%20the%20Market%20Risk%20 Premium%20March%202012.pdf

The Market Risk Premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy, 20 February 2012, http://www.aer.gov.au/content/item.phtml?itemId=752660&nodeId=fe0280e7e2113c467 dfc4b3b076e1623&fn=Vic%20DNSPs%20(NERA)%20-%2020%20February%202012.pdf

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

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

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

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

New Gamma Issues Raised by AER Expert Consultants: A report for JGN, 17 May 2010, http://www.aer.gov.au/content/item.phtml?itemId=736652&nodeId=dea01451551935038 4275dccc6b56018&fn=JGN%20further%20submission%20on%20gamma%20(18%20M ay%202010).pdf

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

Jemena Access Arrangement Proposal for the NSW Gas Networks: AER Draft Decision: A report for Jemena, 19 March 2010, http://www.aer.gov.au/content/item.phtml?itemId=735229&nodeId=4dc041cfe6e30a2c2 b91e833cad31191&fn=Appendix%205.1%20-%20NERA%20- %20FAMA%20French%20Report.pdf

Payout Ratio of Regulated Firms: A report for Gilbert + Tobin, 5 January 2010, http://www.aer.gov.au/content/item.phtml?itemId=735236&nodeId=10e87413b13d1da23 cd55faf20a6918d&fn=Appendix%206.3D%20- %20NERA%20(4%20Jan%2010,%20ETSA)%20Payout%20ratio%20of%20regulated%2 0firms.pdf

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

The Value of Imputation Credits for a Regulated Gas Distribution Business: A report for WA Gas Networks, 18 August 2009, summarized in: http://www.erawa.com.au/cproot/8357/2/20100215%20WAGN%20- %20Proposed%20Revisions%20to%20the%20AA%20for%20the%20WAGN%20Gas%2 0Distribution%20Systems%20Submission%20-%20Public%20Version.pdf

Cost Of Equity - Fama-French Three-Factor Model Jemena Gas Networks (NSW), 12 August 2009, http://www.aer.gov.au/content/item.phtml?itemId=730699&nodeId=4fcc57398775fe846 85434e0b749d76a&fn=Appendix%209.1%20-%20NERA%20- %20Cost%20of%20equity%20-%20Fama-French%20Model.pdf

Estimates of the Cost of Equity: A report for WAGN, 22 April 2009, summarized in:
http://www.erawa.com.au/cproot/8357/2/20100215%20WAGN%20-
%20Proposed%20Revisions%20to%20the%20AA%20for%20the%20WAGN%20Gas%2
0Distribution%20Systems%20Submission%20-%20Public%20Version.pdf

AER's Proposed WACC Statement – Gamma: A report for the Joint Industry
Associations, 30 January 2009,
http://www.aer.gov.au/content/item.phtml?itemId=726698&nodeId=80cf978278d317e99
c34ae1878525573&fn=JIA%20Appendix%20Q%20-%20NERA%20-
%20AER's%20proposed%20WACC%20statement-Gamma.pdf

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

Consulting Experience

NERA, 2008-present

Lumina Foundation, Indianapolis, 2009

Industry Funds Management, 2010

Academic Publications

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

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

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

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

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

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

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

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

Working Papers

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

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

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

Evaluating asset pricing models, 1998.

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

Testing asset pricing models with infrequently measured factors, 1989.

Refereeing Experience

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

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

Teaching Experience

International Finance, Melbourne Business School, 2008

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

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

Investments, University of Chicago, 1993-1994

Investments, University of British Columbia, 1986

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

Investments, Macroeconomics, Statistics, University of Rochester, 1982

Accounting, 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, EXP, LaTex, Matlab, Powerpoint, Visual Basic. Familiar with the Australian School of Business, 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

Brendan Quach

Senior Consultant

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Website: www.nera.com

Overview

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

Qualifications

1991-1995	**AUSTRALIAN NATIONAL UNIVERSITY** Bachelor of Economics. (High Second Class Honours)
1991-1997	**AUSTRALIAN NATIONAL UNIVERSITY** Bachelor of Laws.

Career Details

2001 -	**NERA ECONOMIC CONSULTING** Economist, Sydney
1998-1999	**AUSTRALIAN CHAMBER OF COMMERCE AND INDUSTRY** Economist, Canberra
1996	**AUSTRALIAN BUREAU OF STATISTICS** Research Officer, Canberra

Project Experience

Industry Analysis

2011	**Energy Networks Association**
	Review of the regulatory frameworks for energy networks

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

2011	**MSAR Office for the Development of the Energy Sector**
	Development of a New Tariff Structure

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

2010	**Industry Funds Management/Queensland Investment Corporation**
	Due diligence, Port of Brisbane

Brendan was retained to advise on various regulatory and competition matters likely to affect the future financial and business performance of the Port of Brisbane, in the context of its sale by the Queensland government.

2010-2011	**Minter Ellison /UNELCO**
	Review of regulatory decision by the Vanuatu regulator

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

2010	**Gilbert + Tobin/Confidential – Telecommunications**
	Incentive Arrangements for Regulated Telecommunications Services

Brendan provided strategic advice to Gilbert + Tobin on possible regulatory arrangements that allow for the efficient delivery of fixed line telecommunications services in the context of the government mandated roll out the National Broadband Network.

2009-10   **EnergyAustralia – NSW Electricity Distribution**
                     Review of Public Lighting Services
                     Brendan provided advice to EnergyAustralia during its electricity
                     distribution price review on the provision of public lighting services.
                     Our work provided strategic and regulatory advice to EnergyAustralia
                     during the appeal of the AER's revenue determination for the 2009-
                     2014 period.

2009   **CitiPower/Powercor**
                     Efficiency carryover mechanisms
                     Assisted in the development of an expert report submitted to the AER
                     on the consistency of carrying-forward accrued negative amounts
                     arising from the application of the ESC's efficiency carryover
                     mechanism with the National Electricity Law and the National
                     Electricity Rules.

2009   **Prime Infrastructure**
                     Sale of Dalrymple Bay Coal Terminal (DBCT)
                     Brendan provided regulatory advice to a number of potential bidders
                     for the assets of DBCT. Advice included an assessment of the rate of
                     return parameters, depreciation, regulatory modelling and the
                     regulatory arrangements in Queensland.

2008-09   **MSAR Office for the Development of the Energy Sector**
                     Review of Electricity Cost and Tariff Structures
                     Review of current and projected costs of electricity provision in
                     Macau, including modelling and analysis of marginal costs and sunk
                     cost attribution to various consumer classes. Our work for the Macau
                     Government has incorporated the development of potential tariff
                     structures (specifically rising block tariff structures) and scenarios,
                     including modelling revenue recovery and cross subsidies.

2008   **Singaporean Ministry for Trade and Industry**
                     Electricity Industry Review
                     NERA was retained by the Singaporean Ministry for Trade and
                     Industry (MTI) to provide a comprehensive review of the Singaporean
                     electricity market. Brendan was involved in the analysis of the costs
                     and benefits arising from the restructuring and reform of the
                     Singaporean electricity industry since the mid 1990's, the estimated
                     costs and benefits of future security of supply and energy
                     diversification approaches. The project required NERA to undertake
                     quantitative dispatch modelling of the Singaporean electricity market.

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

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

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

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

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

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

2003	**Metrowater, New Zealand**
	Institutional Restructuring
	Prepared advice for the board of the Auckland City Water and wastewater service provider, Metrowater on options for institutional and regulatory reform of the entire Auckland regional water sector.
2002 - 2003	**Rail Infrastructure Corporation, Australia**
	Research to RIC on their proposed access undertaking.
	Provided research and advice into various components of RICs proposed access undertaking with the ACCC including the cost of capital, asset valuation and pricing principles.
2002	**Argus Telecommunications, Australia**
	Critique of CIE's bandwidth pricing principles.
	Provided a critique of a CIE report on bandwidth pricing principles for the fibre optic networked run owned by Argus Telecommunications.
2001	**Screenrights, Australia**
	Advice on valuing retransmission of local TV
	A review and analysis of different methodologies in valuing retransmission of local television on pay TV services.

Regulatory and Financial Analysis

2012	**Queensland Competition Authority**
	Review of the retail water regulatory models
	Brendan undertook an independent quality assurance assessment of the financial models relied on by the QCA to set the regulated revenues of SunWater. The review considered: SunWater's Financial model, a model used by SunWater to calculate future electricity prices, an renewals annuity model, as well as the QCA's regulatory model. These models established a set of recommended prices for each of the 30 irrigation schemes operated by SunWater for the period 2014 to 2019.
2011	**Queensland Competition Authority**
	Review of the retail water regulatory models
	Undertook an independent quality assurance assessment of the models used to calculate regulated revenues for Queensland Urban Utilities, Allconnex Water, and Unitywater. The review considered: the formulation of the WACC; the intra year timing of cashflows; and the structural, computational and economic integrity of the models.
2011	**Queensland Competition Authority**
	Review of the wholesale water regulatory models
	Undertook an independent quality assurance assessment of the models used to calculate regulated revenues for LinkWater, Seqwater; and

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

2011   **Multinet Gas and SP AusNet - Gas Distribution**
                           Report on the market risk premium
                           Co-authored a report that examined a number of issues arising from the draft decision on Envestra's access proposal for the SA gas network. The report considered whether: the historical evidence supported the use of a long term average of 6 per cent; there is any evidence to warrant a MRP at it long term average; and the evidence relied on by the AER to justify its return to a MRP of 6 per cent.

2011   **Dampier to Bunbury Natural Gas Pipeline - Gas Transmission**
                           Cost of Equity
                           Co-authored two reports that updated the cost of equity for a gas transmission business and responded to issues raised by the regulator in its draft decision. The report re-estimated the cost of equity of a gas distribution business using the Sharpe Lintner CAPM, Black CAPM, Fama-French three-factor model and a zero beta version of the Fama-French three-factor model.

2010-2011   **Queensland Competition Authority**
                           Weighted Average Cost of Capital (WACC) for SunWater
                           Retained to provide two expert reports on the WACC for SunWater a Queensland rural infrastructure business. The first report considered issues pertaining to whether a single or multiple rates of return can be applied across SunWater's network segments. The second report focuses market evidence on the appropriate rate of return for SunWater.

2011   **Mallesons Stephens Jaques, on behalf of ActewAGL Distribution**
                           Determining the averaging period
                           Assisted in the development of an expert report that considered the economic and financial matters arising from the Australian Energy Regulator's decision to reject ActewAGL's proposed risk free rate averaging period.

2010   **Orion Energy, New Zealand**
                           Information disclosure regime
                           Provided advice and assistance in preparing submissions by Orion to the New Zealand Commerce Commission, in relation to the Commission's proposed weighted average cost of capital for an electricity lines businesses. Issues addressed included the financial model used to calculate the required return on equity, the appropriate term for the risk free rate and the WACC parameter values proposed by the Commission.

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

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

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

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

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

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

2009-10	**Jemena - Gas Distribution** **Cost of Equity**

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

2009	**WA Gas Networks - Gas Distribution** **Cost of Equity**

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

2009   **CitiPower and Powercor – Victorian Electricity Distribution**
                                 Network Reliability Incentive Mechanism (S-factor)

Brendan provided advice to CitiPower and Powercor on the proposed changes to the operation of the reliability incentive mechanism. The advice considered the effects of the proposed changes to the operation of the two distribution network service providers. Specifically, how the 'S-factors' would be changed and implications this has to the revenue streams of the two businesses. A comparison was also made with the current ESC arrangements to highlight the changes to the mechanism.

2009   **CitiPower and Powercor – Victorian Electricity Distribution**
                                 Network Reliability Incentive Mechanism (S-factor)

Brendan provided advice to CitiPower and Powercor on the proposed changes to the operation of the reliability incentive mechanism. The advice considered the effects of the new arrangements on the business case for undertaking a series of reliability projects. Specifically, the project estimated the net benefit to the businesses of three reliability programs.

2009   **Jemena and ActewAGL - Gas Distribution**
                                 Cost of Equity

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

2008   **Joint Industry Associations - APIA, ENA and Grid Australia**
                                 Weighted Average Cost of Capital

Assisted in the drafting of the Joint Industry Associations submission to the Australian Energy Regulator's weighted average cost of capital review. The submission examined the current market evidence of the cost of capital for Australian regulated electricity transmission and distribution businesses.

2008   **Joint Industry Associations - APIA, ENA and Grid Australia**
                                 Weighted Average Cost of Capital

Expert report for the Joint Industry Associations on the value of imputation credits. The expert report was attached to their submission to the Australian Energy Regulator's weighted average cost of capital review. The report examined the current evidence of the market value of imputation credits (gamma) created by Australian regulated electricity transmission and distribution businesses.

2007-2008   **Smart Meter Working Group, Ministerial Council on Energy –**
                         Assessment of the costs and benefits of a national mandated rollout
                         of smart metering and direct load control
                         Part of a project team that considered the costs and benefits of a
                         national mandated rollout of electricity smart meters. Brendan was
                         primarily responsible for the collection of data and the modelling of
                         the overall costs and benefits of smart metering functions and
                         scenarios. The analysis also considering the likely costs and benefits
                         associated with the likely demand responses from consumers and
                         impacts on vulnerable customers.

2007   **Electricity Transmission Network Owners Forum (ETNOF),**
                         Submission to the AER on the proposed transmission revenue and
                         asset value models
                         Developed and drafted a submission to the AER on the proposed post-
                         tax revenue model (PTRM) and roll forward model (RFM) that would
                         apply to all electricity transmission network service providers
                         (TNSPs). The proposal focused ensuring that the regulatory models
                         gave effect to the AER's regulatory decisions and insures that TNSPs
                         have a reasonable opportunity to recover their efficient costs.

2007   **Victorian Electricity Distribution Business**
                         Review of Smart Meter model
                         Reviewed the smart meter model developed by a Victorian distributor
                         and submitted to the Victorian Essential Service Commission (ESC).
                         The smart meter model supported the business' regulatory proposal
                         that quantified the revenue required to meet the mandated roll out of
                         smart meters in Victoria. The smart meter model the quantified the
                         expected, meter, installation, communications, IT and project
                         management costs associated with the introduction of smart meters.
                         Further, the estimated the expected change in the business' meter
                         reading and other ongoing costs attributed with the introduction of
                         smart meter infrastructure.

2007   **Energy Trade Associations - APIA, ENA and Grid Australia**
                         Weighted Average Cost of Capital
                         Expert reports submitted to the Victorian Essential Services
                         Commission evaluating its draft decision to set the equity beta at 0.7,
                         and its methodology for determining the appropriate real risk free rate
                         of interest, for the purpose of determining the allowed rate of return for
                         gas distribution businesses.

2007   **Babcock and Brown Infrastructure, Qld**
                         Review of Regulatory Modelling
                         Provided advice to Babcock and Brown Infrastructure on the
                         regulatory modelling of revenues and asset values of the Dalrymple
                         Bay Coal Terminal (DBCT). DBCT has undertaken a substantial

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

2007-   **ActewAGL, ACT**
                   Transition to National Electricity Regulation
                   Providing on-going advice to ActewAGL, the ACT electricity distribution network service provider, on its move to the national energy regulation. The advice covers the revenue and asset modelling, the development of a tax asset base, the new incentives for efficient operating and capital expenditure and processes for compliance, monitoring and reporting of its regulatory activities.

2007 - 2008   **Smart Meter Working Group, Ministerial Council on Energy –**
                   Assessment of the costs and benefits of a national mandated rollout
                   of smart metering and direct load control
                   Brendan was a member of NERA team that investigated the costs and benefits of a national mandated rollout of electricity smart meters. Brendan's prime responsibility was to undertake the modelling of the costs and benefits of smart metering. NERA's assignment required an assessment of smart metering functions and scenarios, and also considering the likely demand responses from consumers and impacts on vulnerable customers.

2005-   **TransGrid, NSW**
                   Review of Regulatory Systems
                   Providing strategic advice to TransGrid, the NSW electricity transmission network service provider, on its current regulatory processes. The advice covers TransGrid's internal systems and processes for compliance, monitoring and reporting of its regulatory activities.

2006   **Grid Australia, National**
                   Submission to application by Stanwell to change the national
                   Electricity Rules (Replacement and Reconfiguration investments)
                   Developed and drafted a submission to the AEMC on the appropriateness of the draft Rule change that extended the application of the regulatory test to replacement and reconfiguration investments.

2006   **Grid Australia, National**
                   Submission to application by MCE to change the national
                   Electricity Rules (Regulatory Test)
                   Developed and drafted a submission to the AEMC on the appropriateness of the draft Rule change which changed the

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Competition Policy

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

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

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

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

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

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

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

Other

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

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

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

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