Attachment 9.1

A Constructive Review of the ERA's Approach to the MRP

Access Arrangement Information

2 October 2017

Access Arrangement Information (AAI) for the period
1 July 2017 to 30 June 2022

A Constructive Review of the ERA's Approach to the MRP

A report for Western Power

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HoustonKemp.com

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Disclaimer

Contents

Figure

Tables

Executive Summary

Western Power has asked HoustonKemp to review the Economic Regulation Authority's (ERA's) current approach to setting the market risk premium (MRP).

The ERA in its DBP decision of June 2016 computes an estimate of the MRP in the following way:[1]

- first, the ERA establishes a range for the MRP; it uses estimates of the long-run average MRP computed from historical data to form a lower bound for the range and estimates computed employing the Dividend Growth Model (DGM) to form an upper bound for the range; and
- second, the ERA chooses a point estimate for the MRP from the range using four forward looking indicators and its own judgement as guides.

Table 1 updates the ERA's table of the historical excess returns to the market to include data for 2016.

Table 1: Estimates of the MRP: Theta = 0.53

	Arithmetic			Geometric		
	BHM	NERA	Average	BHM	NERA	Average
1883-2016	6.41	6.77	6.59	5.05	5.40	5.22
	(1.42)	(1.42)	(1.42)	(1.50)	(1.51)	(1.51)
1937-2016	6.19	6.12	6.15	4.32	4.26	4.29
	(2.16)	(2.16)	(2.16)	(2.27)	(2.27)	(2.27)
1958-2016	6.61	6.61	6.61	4.25	4.25	4.25
	(2.83)	(2.83)	(2.83)	(2.98)	(2.98)	(2.98)
1980-2016	6.30	6.30	6.30	3.98	3.98	3.98
	(3.52)	(3.52)	(3.52)	(3.77)	(3.77)	(3.77)
1988-2016	5.78	5.78	5.78	4.12	4.12	4.12
	(3.25)	(3.25)	(3.25)	(3.70)	(3.70)	(3.70)

Notes: Estimates in per cent per annum are outside of parentheses and standard errors in per cent per annum are in parentheses. Standard errors for the geometric mean presume that one plus the excess return to the market is lognormally distributed. The MRP is computed, following the ERA, relative to the average of the three-month bill yield and 10-year bond yield.

In section 3 of this report we conclude that the best estimate of the long-run average MRP using historical excess returns is 6.77 per cent, which is calculated from the arithmetic mean of the excess return to the market portfolio over the risk-free rate using data from 1883 to 2016 constructed employing adjustments provided by NERA. This recommendation is based on the following changes to the ERA's current approach:

- a sole reliance on the NERA data set, consistent with the approach adopted by market practitioners like Dimson, Marsh and Staunton;

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[1] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016-202*, 30 June 2016.

- the use of an estimate that employs the longest series of returns available, to raise the precision of the MRP estimate; and
- a sole reliance on the arithmetic mean of the series; we recommend that the ERA, to avoid introducing a downward bias into its estimates of the MRP, place no weight on geometric means.

Table 2, updates the ERA's DGM estimates by:

- providing a prevailing MRP estimate using the ERA's two-stage DGM; and
- using the most recent AER DGM analysis, from its final decision for TasNetworks in April 2017.

Table 2: Updated recent MRP estimates in per cent using the DGM, May 2017 (using a consistent gamma/theta value and five-year risk-free rate)

Study/Author	Date	Decision Implied MRP	Consistent gamma/theta	Consistent gamma/theta & Rf
AER[2]	April 2017	6.49 – 7.72	6.39 – 7.63	6.98 – 8.21
ERA	23 May 2017	7.93	7.93	7.93
Estimated range of the MRP consistent with a gamma/theta		**6.5 – 7.9**	**6.4 – 7.9**	**7.0 – 8.2**

Using these estimates results in an implied MRP range of 6.5 to 7.9 per cent. However, the AER adopt a value for gamma and a term for the risk-free rate that differ from the ERA's choice for theta of 0.53 and choice for a term of five years. Table 2 shows that adjusting the recent AER DGM study for these differences results in an adjusted MRP range of between 7.0 to 8.2 per cent.

In section 4 of this report we note that the ERA uses the highest implied MRP estimate from recent DGM studies as an upper bound for the MRP. Applying this approach results in an upper bound of the MRP range of 8.2 per cent.

This results in a range for the five-year forward looking MRP of 6.8 to 8.2 per cent, with a midpoint of **7.5 per cent**.

Finally, section 5 of this report reviews the ERA's use of forward looking indicators for the MRP to determine a point estimate for the MRP from within the range that it constructs. Our review finds that:

- there is some evidence for using default spreads, dividend yields and interest-rate swap spreads as forward looking indicators for the MRP, with prevailing observations of each of these indicators close to their historical means;
- the evidence for a positive relation between the MRP and implied volatility through time is weak, and so, while the current level of the S&P/ASX 200 VIX is low relative to its history over the last 20 years, little weight should be placed on forecasts generated by this indicator;
- there are a number of indicators that the ERA should also include in its deliberations, including:
    - **the prevailing bill rate** – evidence of a negative relation between the MRP and the bill rate coupled with the observation that the bill rate currently lies well below its historical mean suggests that the MRP currently lies above the average level at which it has sat in past years;

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[2] AER, *TasNetworks distribution determination 2017-19 | Final decision | Attachment 3 – rate of return*, 28 April 2017 p. 222.

  - **Wright’s estimate of the MRP** – which currently lies at 8.85 per cent, which suggests that the midpoint of MRP range is a conservative estimate of the prevailing MRP; and
  - **values for the MRP drawn from independent expert reports** – these reports, prepared by accredited independent experts working within an explicit regime of regulation that requires that the experts be accountable for the results of their work, provide an indication of values for the MRP that practitioners are currently using; reports in 2016 indicate that experts are effectively using an MRP of between 7.8 and 9.6 per cent; and
- an approach that systematically examines the ability of a range of indicators, used together, to predict the return to the market portfolio in excess of the risk-free rate is, in our opinion, the preferred method for using forward looking indicators to set the point estimate of the MRP; however, adopting this approach would require a substantial change to the ERA’s methodology.

1. Introduction

Western Power has asked HoustonKemp to comment on the Economic Regulation Authority's (ERA's) current approach for setting the market risk premium (MRP). The ERA in its DBP decision of June 2016 computes an estimate of the MRP in the following way:[3]

- first, the ERA establishes a range for the MRP; it uses estimates of the long-run average MRP computed from historical data to form a lower bound for the range and estimates computed employing the DGM to form an upper bound for the range; and
- second, the ERA chooses a point estimate for the MRP from the range using four forward looking indicators and its own judgement as guides.

HoustonKemp has looked at each part of this process and suggests a number of improvements. The rest of the report is organised as follows:

- section 2 outlines our understanding of how the ERA currently estimates the MRP;
- section 3 provides estimates of the long-run average MRP and analyses the way in which the ERA, in its DBP decision, distils estimates like these into a single lower bound for the MRP;
- section 4 reports estimates of the MRP from recent Dividend Growth Model (DGM) studies and suggests changes to the way in which these estimates are used;
- section 5 considers the ERA's use of forward looking indicators; and
- section 6 sets out our suggested refinements to the ERA's approach to determining the MRP.

In addition Appendix A1 provides a derivation of the bias that can be associated with an estimator for the mean return to an asset that uses the geometric mean.

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[3] ERA, *Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016-2020 | Appendix 4 Rate of Return*, 30 June 2016.

2. Context

The ERA adopts the Sharpe-Lintner Capital Asset Pricing Model (CAPM) to estimate the return on equity in AA3. This model states that:

$$r_e = r_f + \beta \times \text{MRP} \tag{1}$$

where

r_f	is the risk-free rate, estimated using the yield on five-year Commonwealth Government Securities;
β	is the equity beta of a benchmark electricity network service provider; and
MRP	is the market risk premium.

This report examines the ERA's current approach to estimating the MRP. In its September 2012 AA3 decision, the ERA chooses an MRP of 6.0 per cent per annum based primarily on an analysis of the average historical return to the market portfolio in excess of the yield on a five-year government bond. The ERA states in its AA3 decision that:[4]

> In summary, based on its own analysis of the estimate of the MRP using 5-years as the term of the nominal risk free rate, various surveys regarding Australia's MRP, and current Australian regulatory practice, the Authority is of the view that the estimate of the MRP using historical data on equity risk premium is the preferred option and that a MRP of 6 per cent is appropriate.

In its *Rate of return guidelines* of December 2013, however, the ERA changes its approach. The ERA concludes in these guidelines that the MRP varies through time and that information beyond the average historical return to the market portfolio in excess of the yield on a five-year government bond must be used to gauge where the MRP sits at any point in time. The ERA states, for example, in its guidelines that:[5]

> The Authority is therefore of the view that there is inconclusive evidence to suggest any qualitative relationship existing between the risk-free rate of return and the MRP. Given the conflicting evidence regarding the relationship between the risk free rate and MRP, it is necessary to use different methodologies, in addition to regulatory judgement in determining the appropriate value of the MRP. However, the implication of the analysis is that the MRP may fluctuate, depending on economic conditions. On this basis, the Authority considers that the forward looking MRP does vary. The Authority is of the view that the direction of that fluctuation – relative to the risk free rate and the return on equity – is not quantifiable. As a consequence, auxiliary information must be used to determine the appropriate point estimate within an estimated range of MRP values.

Similarly, the ERA states in its DBP of June 2016 decision that:[6]

> … its previous long run historical estimate of 6 per cent could be a poor predictor of the MRP prevailing in future regulatory periods. The Authority therefore dropped the fixed estimate of 6 per cent, instead establishing a range of possible future outcomes for the MRP, informed by information that a rational market participant would use in making investment decisions.

The ERA's current approach is to apply a two-step approach to setting the MRP by:

- establishing a range of possible outcomes for the MRP; and then

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[4] ERA, *Final Decision on Proposed Revisions to the Access Arrangement for the Western Power Network*, 5 September 2012, p. 381.

[5] ERA, *Explanatory Statement for the Rate of Return Guideline*, 16 December 2013, p. 147.

[6] ERA, *Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016-2020 | Appendix 4 Rate of Return*, 30 June 2016, p. 103.

- determining an MRP point estimate using forward looking indicators.

2.1 Determining the MRP range

2.1.1 Lower bound of the MRP range

The ERA estimates the lower bound of the forward looking MRP by reference to the long-run average MRP. We note that were the MRP to lie below its long-run average, the long-run average would provide an upper bound for the MRP rather than a lower bound.

To estimate the long-run average MRP, the ERA uses data provided by both:

- Brailsford, Handley and Maheswaran; and
- Simon Wheatley, formerly of NERA.[7]

The ERA sets a lower bound for the MRP by placing an equal weight on:

- the lowest arithmetic mean of a series of returns to the market portfolio, in excess of the yield on a five-year government bond, of a selection of arithmetic means produced for five overlapping periods; and
- the highest geometric mean of a similar selection of geometric means.

2.1.2 Upper bound of the MRP range

An upper bound for the MRP is determined by reference to the top of a range of the MRP estimates produced from, recent DGM studies. These estimates include one that uses the ERA's two-stage DGM.

The ERA's two-stage DGM uses the following inputs:

- a long-run dividend growth rate of 4.6 per cent, relying on the analysis sets out in Lally's 2013 study;[8]
- Bloomberg sourced estimates for:
    - the monthly net dividend per share forecasts for the All Ordinaries Index; and
    - the monthly closing price for the All Ordinaries Index;
- an assumption that 75 per cent of all dividends are franked (that is every dollar of dividends distributed has attached to it $0.75 × 0.3 ÷ 0.7 = $0.32 in franking credits) and
- a value of distributed franking credits of 0.53 (which is consistent with a gamma value of 0.4 and a distribution rate of 0.75).

2.2 Setting the MRP point estimate

The final step is to determine an MRP point estimate from within a range for the MRP. This step involves the ERA having regard to the following four forward looking indicators:[9]

- the dividend yield on the All Ordinaries;
- the five-year interest-rate swap spread;
- the default spread on an AA bond, that is, the default risk premium (DRP) on AA bonds; and
- the S&P/ASX 200 volatility index (VIX).

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[7] Note that Simon Wheatley is now a special adviser to HoustonKemp.

[8] M. Lally, *The Dividend Growth Model,* 4 March 2013, p. 17.

[9] ERA, *Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016-2020 | Appendix 4 Rate of Return*, 30 June 2016, p. 120.

3. Estimates of the Long-Run Average MRP

In this section, we provide estimates of the long-run average MRP computed from historical data and analyse the way in which the ERA, in its DBP decision, distils estimates like these into a single lower bound for the MRP.

3.1 Estimates

The ERA provides estimates of the MRP that use:

- five overlapping periods;
- data from Brailsford, Handley and Maheswaran (2012) and NERA (2013) extended through to 2015;[10]
- an assumption that the value of a one-dollar imputation credit distributed, theta, is 53 cents;
- arithmetic and geometric means; and
- the yield on a five-year Commonwealth Government bond estimated as the average of the three-month bill and 10-year bond yields.

The five overlapping periods that the ERA uses are the five periods that Brailsford, Handley and Maheswaran examine extended through to 2015. We extend these periods a further year to 2016.

The data that Brailsford, Handley and Maheswaran provide and the data that NERA provides employ a series of yields that Lamberton (1961) supplies.[11] Brailsford, Handley and Maheswaran (2008) suggest that the series that Lamberton supplies overstates the yield on the Commercial and Industrial/All Ordinaries price series that Lamberton (1958) also supplies.[12] Evidence from original sources for the yields that NERA provides in June 2013, October 2013 and June 2015 suggests that some adjustments should be made to Lamberton's yield data but that the adjustments should be smaller, on average, than the adjustments that Brailsford, Handley and Maheswaran believe to be appropriate.[13] The NERA-adjusted data that we use employ the adjustments that NERA makes in its June 2015 report.

To produce with-credit returns, we add to the with-dividend return 53 per cent of the credit return – that is, the ratio of the credits provided by the All Ordinaries within a year to the level of the index at the start of the year.

Table 3 provides estimates for the five overlapping periods using the data of Brailsford, Handley and Maheswaran (BHM) and NERA, extended through to 2016, and arithmetic and geometric means. The

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[10] 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, pp. 237-247.

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

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

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

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

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

[13] NERA, *Market, size and value premiums: A report for the ENA*, June 2013.

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

NERA, *Further assessment of the historical MRP: Response to the AER's final decisions for the NSW and ACT electricity distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015.

estimates that we provide differ marginally from the estimates that the ERA provides in its DBP decision of June 2016. [14]

Part of the reason for the difference lies in the fact that the return to the market in 2016 was relatively high. The gross return to the All Ordinaries from December 2015 to December 2016 was 13.71 per cent while the yield on a five-year Commonwealth Government bond, estimated, following the ERA, as the average of the three-month bill and 10-year bond yields, at the end of 2016 was 2.43 per cent. Thus the excess return to the market portfolio, computed in the same way that Brailsford, Handley and Maheswaran compute the return, was 11.28 per cent – considerably above its long-run average. As a result, estimates of the MRP rise with the addition of 2016 data.

Table 3: Estimates of the MRP: Theta = 0.53

	Arithmetic			Geometric		
	BHM	NERA	Average	BHM	NERA	Average
1883-2016	6.41	6.77	6.59	5.05	5.40	5.22
	(1.42)	(1.42)	(1.42)	(1.50)	(1.51)	(1.51)
1937-2016	6.19	6.12	6.15	4.32	4.26	4.29
	(2.16)	(2.16)	(2.16)	(2.27)	(2.27)	(2.27)
1958-2016	6.61	6.61	6.61	4.25	4.25	4.25
	(2.83)	(2.83)	(2.83)	(2.98)	(2.98)	(2.98)
1980-2016	6.30	6.30	6.30	3.98	3.98	3.98
	(3.52)	(3.52)	(3.52)	(3.77)	(3.77)	(3.77)
1988-2016	5.78	5.78	5.78	4.12	4.12	4.12
	(3.25)	(3.25)	(3.25)	(3.70)	(3.70)	(3.70)

Notes: Estimates in per cent per annum are outside of parentheses and standard errors in per cent per annum are in parentheses. Standard errors for the geometric mean presume that one plus the excess return to the market is lognormally distributed. The MRP is computed, following the ERA, relative to the average of the three-month bill yield and 10-year bond yield.

Another reason for a difference between our results and those that the ERA supplies is that while we follow Brailsford, Handley and Maheswaran and use Australian Taxation Office (ATO) data on credit yields from 1998 onwards and assume, prior to 1998, that dividends are 75 per cent franked, the ERA, in its DBP decision of 2016, assumes instead that dividends are 75 per cent franked both before 1998 and from 1998 onwards and does not use ATO yields.[15]

There are two points that are worth making about the estimates that Table 3 provides.

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[14] Note that Table 4 and Table 7 in the ERA's DBP Final Decision of 2016 are mislabelled. The title to Table 4 states that the nominal and real returns to the market that appear in the table are without imputation credits. In fact, the nominal returns are without imputation credits but the real returns are with imputation credits. Table 7 has the labels for the BHM and NERA estimates around the wrong way.

[15] Note that the ERA confuses the rate at which dividends are franked with the rate at which credits created are distributed. The two quantities need not be equal. See footnote 438 of the DBP Final Decision:

ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 111.

First, estimates of the MRP are imprecise and estimates that use shorter time series are less precise than estimates that use longer time series. A 95 per cent confidence interval for the MRP, in per cent per annum, that uses the arithmetic mean of the series of excess returns to the market portfolio from 1883 to 2016 is:

$$6.59 \pm 1.96 \times 1.42 \tag{2}$$

That is, a 95 per cent confidence interval for the MRP that uses the arithmetic mean and data from 1883 to 2016 is 3.81 to 9.37 per cent per annum. A 95 per cent confidence interval for the MRP, in per cent per annum, that uses the arithmetic mean of the series of excess returns to the market portfolio from 1988 to 2016 is:

$$5.78 \pm 1.96 \times 3.25 \tag{3}$$

That is, a 95 per cent confidence interval for the MRP that uses the arithmetic mean and data from 1988 to 2016 is -0.59 to 12.15 per cent per annum.

Second, it is well known that while the arithmetic mean provides an unbiased estimator for the annual MRP, the geometric mean provides a downwardly biased. [16] This property of geometric means explains why the geometric means lie so far below their arithmetic counterparts.

The approach that the ERA uses in its DBP decision is to employ simple averages of the estimates that it computes using the BHM and NERA data and, as a lower bound for the MRP, a simple average of the lowest arithmetic mean across the five periods and the highest geometric mean. Using this approach, a lower bound for the MRP would be a simple average of:

- the lowest arithmetic mean of 5.78 per cent (from the 1988-2016 period); and
- the highest geometric mean of 5.22 per cent (from the 1883-2016 period).

This would result in a lower bound for the MRP of 5.50 per cent, which is slightly higher than the 5.40 per cent determined for DBP in June 2016. However, in what follows we offer some suggestions for how the ERA might better compute a lower bound for its range for the MRP.

3.2 Analysis

3.2.1 Equally weighting the BHM and NERA data

The ERA employs simple averages of the estimates that it computes using the BHM and NERA data. The rationale that the ERA gives for employing simple averages is that Handley, in October 2014, suggests that the adjustments that NERA recommends that one make to the historical data may be sensitive to the source used to provide dividend yields and that NERA is unable to come close to matching the yields that Lamberton supplies. The ERA states that:[17]

> With regard to data quality, the BHM historic series are claimed to be downwardly biased on account of an inadequate adjustment made to the dividend yields employed in the data. To address this perceived issue, in 2013 NERA produced an Australian stock market total return series that readjusted the dividend yields prior to 1957.
>
> Handley's advice to the AER prepared in October 2014 raised a number of concerns regarding the analysis underlying the NERA (2013) data. In particular, he highlighted a lack of consistency between NERA's source of dividend yields and those employed by Lamberton on which the BHM series was based. Additionally, he highlighted that NERA had not reconciled their adjusted yields with those of Lamberton. The Authority therefore is of the view that the analysis

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[16] NERA (2012) provides evidence from simulations that illustrates the magnitude of the bias.

NERA, *The market risk premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy*, February 2012, pp. 3-12.

[17] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 110.

> underlying the NERA (2013) data is insufficient grounds to justify the full upward adjustment to the BHM series performed by NERA.
>
> Given the uncertainty surrounding the most appropriate adjustment to the market return series, the Authority has used an average of the two series to minimise any potential error with use of either series alone.

NERA, in a June 2015 report, examines the issues that Handley raises and finds that the adjustments that it recommends that one make to the historical data are not sensitive to the source used to provide dividend yields and that it is able to come close to matching the yields that Lamberton supplies. In particular, NERA states that: [18]

> Our data, like the data that the AER uses, employs a series of yields that Lamberton (1961) provides. Brailsford, Handley and Maheswaran (2008) suggest that the series that Lamberton provides overstates the yield on the Commercial and Industrial/All Ordinaries price series that Lamberton (1958) also supplies. The evidence that we provide in our June 2013 and October 2013 reports suggests that some adjustment should be made to Lamberton's yield data but that the adjustment should be smaller than the adjustment that Brailsford, Handley and Maheswaran believe to be appropriate. Here, we examine the issue further. In particular, we make a number of changes to examine the sensitivity of our estimates of the *MRP* to the data that we use. We find that only two of the changes affect an estimate of the *MRP* computed over the period 1883 to 2014 by more than one half of a basis point.
>
> Handley (2015) and the AER (2015) suggest that the adjustments that we make to Lamberton's data are unreliable because of small differences between an equally weighted yield series that we construct and the equally weighted yield series that Lamberton (1961) provides. We emphasise in our February 2014 report that we do not use the equally weighted yields that we compute to construct an estimate of the *MRP*. We use instead the value-weighted yields that we compute that employ only those stocks that Lamberton uses to produce his price index. We compute equally weighted yields solely so that we can examine how closely we can come to recreating Lamberton's yields, which are also equally weighted, for the quarters that we examine. Here we examine the impact of interpreting a reference made by the SSE *Official Gazette* to 'all ordinary shares' as not to the shares that Lamberton uses to construct his price indices, but instead to all shares irrespective of whether they play a role in constructing a series of prices. When we use all shares irrespective of whether they play a role in constructing Lamberton's price series we are better able to reproduce Lamberton's yields. The correlation between our estimate of the equally weighted average yield to dividend paying issues (firms) and Lamberton's estimate is 1.00 (0.98) (rounded to two decimal places) across the seven years that we examine. The mean of our seven estimates of the equally weighted average yield to dividend paying issues (firms) is 7.43 (7.38) per cent per annum while the mean of his seven estimates is 7.38 per cent per annum.

We note that Elroy Dimson of Cambridge University and the London Business School and Paul Marsh and Mike Staunton of the London Business School, while aware of the adjustments that Brailsford, Handley and Maheswaran employ, have refrained from using the adjustments in editions of their Credit Suisse Global Investment Returns Sourcebook and Yearbook. Dimson, Marsh and Staunton, on the other hand, make clear that the 2016 and 2017 editions of their Credit Suisse Global Investment Returns Sourcebook and Yearbook use the adjustments that NERA provides.

Dimson, Marsh and Staunton, for example, state in their Credit Suisse Global Investment Returns Sourcebook 2015 that:[19]

> The data for equities were provided by the author of Officer (1989). He uses Lamberton's (1958a,b) data, linked over the period 1958-74 to an accumulation index of 50 shares from the

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[18] NERA, *Further assessment of the historical MRP: Response to the AER's final decisions for the NSW and ACT electricity distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015, pp. i-iii.

[19] Dimson, E., P. Marsh and M. Staunton, *Credit Suisse Global Investment Returns Sourcebook 2015*, February 2015, p. 61.

> Australian Graduate School of Management (AGSM) and over 1975-79 to the AGSM value-weighted accumulation index. Subsequently, we use the Australia All-Ordinary index. Brailsford, Handley and Maheswaran (2008) argue that pre-1958 dividends are overstated by Lamberton, but do not present alternative annual dividend estimates, and we continue to use Officer's dataset.

Officer's dataset uses Lamberton's series of dividend yields without any adjustments having been made. Dimson, Marsh and Staunton, on the other hand, state in their Credit Suisse Global Investment Returns Sourcebook 2016 (and an almost identical statement appears in their Credit Suisse Global Investment Returns Sourcebook 2017) that:[20]

> The data for equities prior to 1958 is based on the Sydney Stock Exchange Commercial and Industrial index. Until last year, we used the yield series provided by Lamberton (1958ab) to convert this to a total return index. Lamberton's yield series was, however, equally weighted, and from this year, we have switched to using the adjustment factors proposed by Wheatley and Quach (2013) in order to convert Lamberton's yields into market value-weighted yields. We are grateful to Simon Wheatley for these adjustment factors and also for pointing out that in previous years our underlying equity price index for this period (kindly provided by Officer, 1989) was based on June and not December year ends. We have now reverted to year-end values.

We recommend that the ERA follow Dimson, Marsh and Staunton and use, solely, the NERA adjustments and refrain, entirely, from using the BHM adjustments, and so the BHM data prior to 1958.

If the ERA were to follow this advice but continue to use, as a lower bound for the MRP, a simple average of the lowest arithmetic mean across the five periods and the highest geometric mean, then a lower bound for the MRP would be a simple average of:

- the lowest arithmetic mean of 5.78 per cent (from the 1988-2016 period); and
- the highest geometric mean of 5.40 per cent (from the 1883-2016 period).

Adopting this improvement would result in a lower bound for the MRP of 5.59 per cent, which is again higher than the 5.40 per cent determined for DBP in June 2016.

3.2.2 Using overlapping periods

The five overlapping periods that the ERA uses in its DBP decision of June 2016 are the five periods that Brailsford, Handley and Maheswaran examine, extended through to 2015, and we extend these periods a further year to 2016. Data from five non-overlapping periods contribute to the 10 MRP estimates that the ERA uses in the following way:

- data from the 29-year period 1988 to 2016 contribute to all 10 of the MRP estimates that the ERA uses;
- data from the eight-year period 1980 to 1987 contribute to eight of the MRP estimates that the ERA uses;
- data from the 22-year period 1958 to 1979 contribute to six of the MRP estimates that the ERA uses;
- data from the 21-year period 1937 to 1957 contribute to four of the MRP estimates that the ERA uses; while
- data from the 54-year period 1883 to 1936 contribute to two of the MRP estimates that the ERA uses.

Placing a larger weight on more recent observations than on less recent observations might sound like an attractive strategy if the long-run average MRP has shifted substantially over time. There is a large cost, however, associated with placing a larger weight on more recent observations than on less recent observations. Placing a larger weight on more recent observations can substantially lower the precision of the estimates that one produces. So unless one suspects that the long-run average MRP has shifted

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[20] Dimson, E., P. Marsh and M. Staunton, *Credit Suisse Global Investment Returns Sourcebook 2015*, February 2016, p. 61.
Dimson, E., P. Marsh and M. Staunton, *Credit Suisse Global Investment Returns Sourcebook 2015*, February 2017, p. 72.

substantially over time, the costs of placing a larger weight on more recent observations than on less recent observations are likely to exceed the benefits of doing so. NERA, in a June 2013 report, provides an analytical demonstration of this conclusion.[21]

3.2.3 Choosing the lowest arithmetic mean and the highest geometric mean

The ERA exercises its judgement to distil estimates of the MRP into a single lower bound for the MRP by taking an average of the estimate that uses the lowest arithmetic mean and the estimate that uses the highest geometric mean.[22] There are two issues that one should consider in assessing this strategy.

First, the estimator for the MRP that uses the lowest arithmetic mean will be a downwardly biased estimator for the long-run average annual MRP because the estimator uses the lowest of a selection of estimates, each of which is unbiased. It is also likely that the estimator will be imprecise as it is likely that it will be based on the arithmetic mean of a sample that excludes some of the data.

Second, the estimator for the MRP that uses the highest geometric mean may be a downwardly or upwardly biased estimator for the long-run average MRP. On the one hand, the estimator for the MRP that uses the highest geometric mean will tend to be an upwardly biased estimator for the long-run average annual MRP because the estimator uses the highest of a selection of estimates. On the other hand, the estimator for the MRP that uses the highest geometric mean will tend to be a downwardly biased estimator for the long-run average annual MRP because the geometric mean provides, as is well known, a downwardly biased estimator for the long-run average annual MRP. It is likely that the estimator that uses the highest geometric mean will also be imprecise as it is likely that it will be based on the geometric mean of a sample that excludes some of the data.

To examine how important these issues are, we conduct bootstrap simulations. We place the annual returns to the market portfolio in excess of the five-year bond yield, from 1883 to 2016, in a 134 × 1 vector. We then form 100,000 samples of 134 observations each by drawing, with replacement, excess returns from the vector. We calculate for each sample:

- the sample mean of all 134 observations;
- the lowest arithmetic mean across the five overlapping periods that the ERA uses;
- the highest geometric mean across the five overlapping periods that the ERA uses; and
- the average of the lowest arithmetic mean and highest geometric mean.

We also examine the impact of splitting the data into two strata:

- the data from 1883 to 1957; and
- the data from 1958 to 2016.

We do so because Kearns and Pagan (1993) show that in Australian data the returns to the market portfolio before 1958 exhibit lower volatility than the returns from 1958 onwards. [23] We ensure that the two sets of data have identical means by: [24]

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[21] NERA, *The market, size and value premiums: A report for the Energy Networks Association*, June 2013, pp. 37-38.

[22] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 119.

[23] Kearns, P. and A. Pagan, *Australian stock market volatility: 1875-1987*. Economic Record 69, 1993, pp. 163-178.

[24] In doing so, we follow the method that Kim, Nelson and Startz (1991) employ.

Kim, M.J., C.R. Nelson and R. Startz, *Mean reversion in stock prices? A reappraisal of the empirical evidence*, Review of Economic Studies 58, 1991, pp. 515-528.

- adding the sample mean of the excess returns from 1883 to 2016 to each excess return from 1883 to 1957 and subtracting the sample mean of the unadjusted excess returns from 1883 to 1957 from each excess return from 1883 to 1957; and
- adding the sample mean of the excess returns from 1883 to 2016 to each excess return from 1958 to 2016 and subtracting the sample mean of the unadjusted excess returns from 1958 to 2016 from each excess return from 1958 to 2016.

With the data split into two strata, we form 100,000 samples of 134 observations each by drawing, with replacement, first, 75 excess returns from a vector containing the data from 1883 to 1957 and, second, 59 excess returns from a vector containing the data from 1958 to 2016.

Table 4 supplies the results of the simulations. The sample mean provides, in general, an unbiased estimate of the population mean and the table confirms this fact.

As we suggest above, the estimator for the MRP that uses the lowest arithmetic mean will be a downwardly biased estimator for the long-run average annual MRP and is likely to be imprecise. The table confirms the suggestion. Moreover, the table indicates that the bias and loss of precision are greater when it is taken into account that the later and shorter periods that the ERA uses contain returns that are more volatile.

The table also indicates that the estimator for the MRP that uses the highest geometric mean may indeed be a downwardly or upwardly biased estimator for the long-run average annual MRP. When the data are not stratified, the estimator turns out to be an upwardly biased estimator while when the data are stratified, the estimator turns out to be a downwardly biased estimator. The table also confirms that the estimator for the MRP that uses the highest geometric mean is imprecise and indicates that the loss of precision is greater when it is taken into account that the later and shorter periods that the ERA uses contain returns that are more volatile.

Finally, the table indicates that the estimator for the MRP that uses a simple average of the lowest arithmetic mean and the highest geometric mean is a downwardly biased estimator for the long-run average annual MRP and is a less precise estimator than the sample mean computed using all of the data. The table also shows that the loss of precision is greater when it is taken into account that the later and shorter periods that the ERA uses contain returns that are more volatile.

Table 4: Results of bootstrap simulations that examine the ERA's strategy

	Population mean	Sample mean computed using all data	Lowest arithmetic mean	Highest geometric mean	Average of lowest arithmetic mean and highest geometric mean
Not stratified	6.77	6.77	5.28	7.00	6.14
		(1.41)	(2.14)	(2.19)	(2.05)
Stratified	6.77	6.78	5.00	6.71	5.85
		(1.39)	(2.78)	(2.60)	(2.54)

Notes: The simulations use 100,000 replications. The stratified simulations place the excess returns to the market from the high-variance period from 1958 onwards in a separate urn from which returns for those years are drawn with replacement when generating artificial histories.

3.2.4 Equally weighting the lowest arithmetic mean and the highest geometric mean

The ERA chooses a simple average of the lowest arithmetic mean and the highest geometric mean because:[25]

> The Authority notes that there are mixed views as to the best estimator of historic returns. Arithmetic average returns will tend to overstate returns, whereas geometric average returns will tend to understate returns. An unbiased estimator is likely to lie somewhere between the two estimates.

It is correct to say that an arithmetic sample mean return when compounded over some period will be an upwardly biased estimator for the corresponding population mean return over the same period. It would be incorrect to say, on the other hand, that an arithmetic sample mean return when not compounded will be an upwardly biased estimator for the corresponding population mean return.

As an example, define A to be the arithmetic mean of a sample of gross annual returns, that is, define:

$$A = \sum_{t=1}^{T} \frac{R(t)}{T}, \tag{4}$$

where:

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

T = the number of observations.

Then assuming that the return to the asset is serially uncorrelated, the expected value of an estimate of the expected return to the asset over two years that uses the arithmetic mean will be:

$$\mathrm{E}(A^2) = [\mathrm{E}(A)]^2 + \mathrm{Var}(A) = \mathrm{E}(R(t)^2) + \mathrm{Var}(A) > \mathrm{E}(R(t)^2). \tag{5}$$

In words, the arithmetic mean when compounded over two years will be an upwardly biased estimator for the unconditional expected two-year return to the asset and the bias will reflect the imprecision with which the arithmetic mean estimates the population mean over one year.[26] The arithmetic mean when not compounded, on the other hand, will be an unbiased estimator for the unconditional expected one-year return to the asset – so long as it exists.[27] That is, it will be true that:

$$\mathrm{E}(A) = \mathrm{E}(R(t)). \tag{6}$$

Table 3 indicates that the variance of the arithmetic sample mean of the NERA series of excess returns to the market portfolio is 1.42 per cent per annum. Equation (5) implies, therefore, that the bias, in per cent, associated with an estimate of the two-year MRP that compounds the arithmetic sample mean is:

$$\mathrm{Var}(A) = 100 \times 0.0142^2 = 0.02 \tag{7}$$

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[25] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, pp. 118-119.

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

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

or around one basis point on an annual basis. On the other hand, using simulations and data from 1883 to 2011, NERA (2012) finds that the bias, in per cent per annum, associated with an estimate of the 10-year MRP that compounds the arithmetic sample mean is:[28]

$$100 \times (1.823^{1/10} - 1.808^{1/10}) = 0.09, \tag{8}$$

that is, nine basis points on an annual basis. Thus the bias associated with an estimator for the MRP over 10 years or less that uses an arithmetic mean computed over a period of 129 years or more is likely to be small.

It is also correct to say that a geometric mean return when compounded over some period can be a downwardly biased estimator for the corresponding population mean return over the same period.

As an example, define G to be the geometric mean of a sample of gross annual returns, that is, define:

$$G = \left[\prod_{t=1}^{T} R(t)\right]^{1/T} \tag{9}$$

and assume, in addition, that:

$$\ln(R(t)) \sim NID(\mu, \sigma^2) \tag{10}$$

Appendix 1 shows that under this assumption the bias associated with an estimator for the mean return to an asset that uses the geometric mean compounded over n periods will be biased downwards when $n < T$.

Estimates of μ and σ that use the NERA data from 1883 to 2016 are 5.26 per cent per annum and 16.60 per cent per annum. It follows using the analysis of Appendix 1 and these estimates that an estimate of the bias associated with an estimator for the one-year MRP that uses the geometric mean will be minus 145 basis points, an estimate of the bias associated with an estimator for the two-year MRP will be minus 144 basis points and an estimate of the bias associated with an estimator for the 10-year MRP will be minus 135 basis points. NERA (2012) reports similar estimates using simulations and data from 1883 to 2011.[29] Thus the bias associated with an estimator for the MRP over 10 years or less that uses the geometric mean computed over a period of 129 years or more is likely to be large.

These two pieces of evidence – on the bias associated with estimators for the MRP – indicate that it may be difficult to justify, on grounds of avoiding bias, placing an equal weight on arithmetic and geometric estimates of the MRP.

We should also note that Lally (2012) and NERA (2012) emphasise that Australian regulators never compound an estimate of the weight average cost of capital that uses the arithmetic mean of a sample of returns and so should avoid completely using geometric means.[30] Lally states about the use of geometric means by the Australian Energy Regulator (AER) that:[31]

> 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.

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[28] NERA, *The market risk premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy*, February 2012, pp. 3-12.

[29] NERA, *The market risk premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy*, February 2012, pp. 3-12.

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

NERA, *The market risk premium: A report for CitiPower, Jemena, Powercor, SP AusNet and United Energy*, February 2012, pp. 3-12.

[31] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, pp. 118-119.

If historical average returns are used, they should be arithmetic rather than geometric averages.

For this reason we recommend that the ERA use only the arithmetic mean of a sample of returns to the market portfolio in excess of a measure of the risk-free rate to estimate the MRP and place no reliance on the geometric mean of the sample. We also recommend that the ERA use the longest possible time series of reliable data to estimate the MRP. Making these recommendations and our earlier recommendation that the ERA use solely the NERA data amounts to recommending that the ERA use the single estimate of the long-run average MRP of 6.77 per cent per annum that uses the NERA data from 1883 to 2016 as the lower bound for the MRP.

4. DGM Estimates of the MRP

This section articulates a number of suggested improvements to the current approach of the ERA to using DGM estimates to establish an upper bound for the MRP.

In the remainder of this section we:

- update the ERA's DGM estimates to incorporate market information up to 23 May 2017;
- provide suggestions about how the ERA should interpret recent DGM estimates of the MRP; and
- report DGM estimates of the MRP implied by recent studies.

4.1 Updated ERA DGM

The ERA adopts the following two-stage DGM to estimate the forward-looking return on the market portfolio:[32]

$$P_0 = \frac{m \times \mathrm{E}(D_0)}{(1+k)^{m/2}} + \sum_{t=1}^{N} \frac{\mathrm{E}(D_t)}{(1+k)^{m+t-0.5}} + \frac{\frac{\mathrm{E}(D_N)(1+g)}{k-g}}{(1+k)^{m+N-0.5}} \tag{11}$$

where:

P_0 is the current level of the All Ordinaries;

m is the fraction of the current year remaining;

D_0 is the amount of dividends that the All Ordinaries is expected to deliver in the current year;

$\mathrm{E}(D_t)$ is the amount of dividends that the All Ordinaries is expected to deliver in year t;

k is the return on the market portfolio implied by the model;

N is the year of the furthest out dividend forecast; and

g is the long-run dividend growth rate, which we assume to be 4.6 per cent, consistent with the value adopted by the ERA in its DBP decision.[33]

Further, to reflect the value franking credits contribute to the return on equity an investor receives, the dividend forecasts reported by Bloomberg for the All Ordinaries are multiplied by the imputation factor:

$$1 + \theta f\left(\frac{\tau}{1-\tau}\right) \tag{12}$$

where:

θ is the market value of franking credits, which is assumed to be either:

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[32] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p 115.

[33] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 116.

  - 0.53 consistent with the ERA's gamma value of 0.40;[34] or
  - 0.35 consistent with the network businesses gamma value of 0.25;[35]

f is the proportion of dividends that are franked, assumed to be 75 per cent;[36] and

τ is the corporate tax rate, 30 per cent.

Figure 1 shows the grossed-up market return on equity implied by the DGM, the MRP implied by the model and the five-year CGS yield from 1 January 2010 to 23 May 2017.

Figure 1 DGM implied MRP: All Ordinaries (returns grossed up with theta of 0.53)

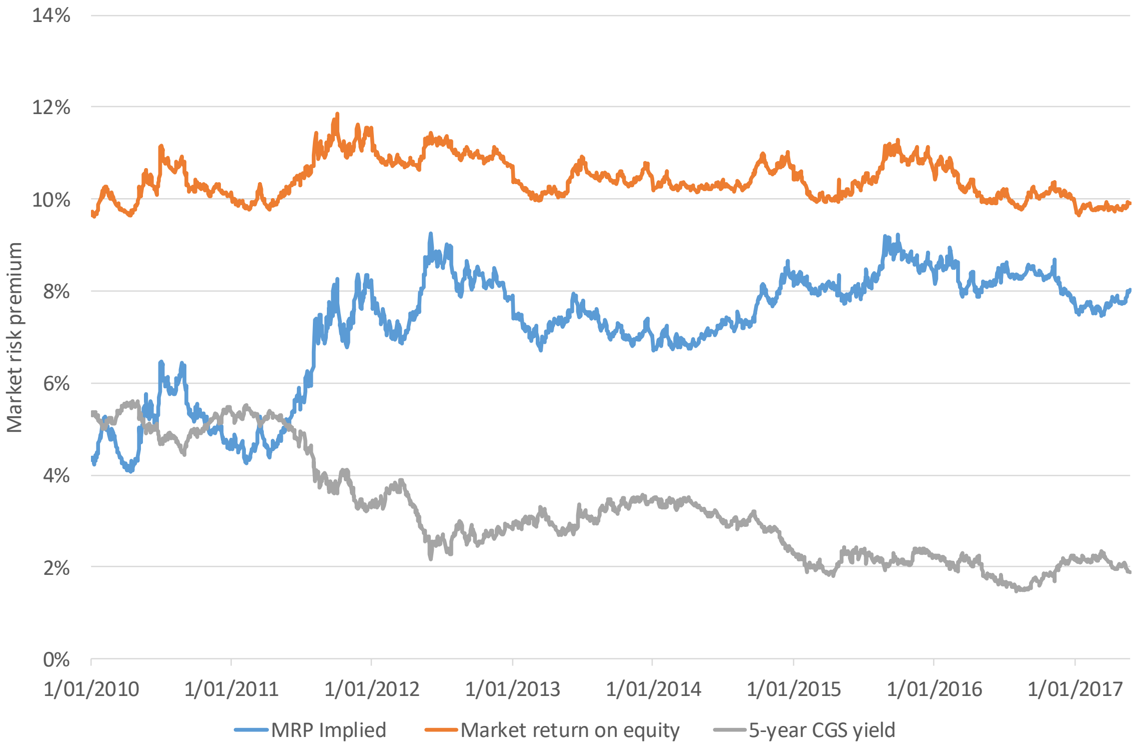

Figure 1 shows that the MRP implied by the DGM was 7.93 per cent on 23 May 2017, under the assumption that theta is 0.53. Under the assumption that theta is 0.35, consistent with a gamma value of 0.25, the implied MRP would fall to 7.66 per cent on this date.

4.2 Interpretation of recent DGM estimates of the MRP

The upper bound for the MRP in the DBP decision is determined by reference to a range of recent DGM estimates of the MRP. Table 5 lists the DGM estimates considered by the ERA in its DBP decision.

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[34] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 111.

[35] SA Power Networks, Revised Regulatory Proposal 2015-20, July 2015, p. 369.

[36] ERA, *Final decision on proposed revisions to the access arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020 submitted by DBNGP (WA) Transmission Pty Limited: Appendix 4 Rate of return*, June 2016, p. 111.

Table 5: Recent estimates of the MRP using the DGM (Table 6 of the ERA's DBP decision)

Study/Author	Date	Dividend yield source	Theta	Risk-free rate (%)	Implied MRP (%)
SFG	May 2015	Thomson Reuters I/B/E/S	0.35	2.55	8.82
Frontier Economics	July 2015	Thomson Reuters I/B/E/S	0.35	2.85	8.35
AER	May 2016	Bloomberg	0.6	2.93	7.57 – 8.84
ERA	May 2016	Bloomberg	0.6	1.82	8.12
Estimated range of the MRP consistent with a gamma of 0.4					**7.6 – 8.8**

The DBP decision adopts an MRP upper bound of 8.8 per cent, the highest DGM estimate of the MRP of the four estimates that the ERA considers.

In our opinion, the ERA's policy of choosing an upper bound for the MRP using recent DGM estimates is commendable. However, we have two suggestions for ensuring that the DGM estimates of the MRP that the ERA uses in a regulatory decision are derived in a way that is consistent with other elements of the ERA's decision. We suggest that the ERA:

- ensure that all estimates of the market return on equity that the regulator employs in a regulatory decision use the value for gamma or theta employed in the decision; and
- calculate the MRP as a margin above the five-year risk-free rate, consistent with the ERA's choice of a term for the risk-free rate to be used in the CAPM.

Using these two suggestions would ensure that DGM estimates of the MRP that the ERA employs in a regulatory decision are indeed derived in a way that is consistent with other elements of the ERA's decision.

4.2.1 Internally consistent estimates of the MRP

The requirement that a regulator calculate the rate of return in an internally consistent manner is a well-accepted regulatory principle. For example, the National Electricity Rules states that:

> … the allowed rate of return for a regulatory year must be ... determined on a nominal vanilla basis that is consistent with the estimate of the value of imputation credits[37]
>
> In determining the allowed rate of return, regard must be had to: … the desirability of using an approach that leads to the consistent application of any estimates of financial parameters that are relevant to the estimates of, and that are common to, the return on equity and the return on debt.[38]

We note, however, that:

- not all of the DGM estimates of the MRP that the ERA uses in its DBP decision are derived employing values for theta or gamma that align with the values used by the ERA in the decision; and

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[37] National Electricity Rules, s. 6.5.2(d)(2).

[38] National Electricity Rules, s. 6.5.2(e)(2).

- most of the DGM estimates of the MRP that the ERA uses in its DBP decision are computed relative to the 10-year risk-free rate rather than the five-year risk-free rate that the ERA employs when using the CAPM.

In our opinion, MRP estimates published by third parties should be adjusted to ensure that the rate of return determined by the ERA is computed on an internally consistent basis. The remainder of this section sets out how MRP estimates cited by the ERA in the DBP decision can be adjusted to ensure internal consistency.

4.2.2 A common theta value

Estimates of the market return on equity derived from DGM studies are influenced by what assumption is made about theta, the value that the market places on a one-dollar imputation credit distributed. There is no consensus on what value theta takes on and so DGM studies use various values for theta. It would be inconsistent to use, in a regulatory decision, DGM estimates of the market return on equity that employ theta values that differ from the value chosen by the ERA in the decision. This point is explicitly recognised in the DBP decision which states that:[39]

> Based on these results [Table 6 of the DBP decision], the Authority judges that a range for the MRP commensurate with a gamma of 0.4 is 7.6 to 8.8 per cent.

None of the DGM estimates that appear in Table 6 of the DBP decision, however, except for the one produced by the ERA, adopt a value for theta of 0.53. An inconsistency arising from this fact can be avoided if the DGM estimates considered by the ERA are adjusted so that they all employ a common theta value.

We note that a number of DGM studies use an alternative assumption about how the market return on equity inclusive of a value for imputation credits should be calculated. The following groups use this alternative assumption:

- SFG Consulting;[40] and
- Frontier Economics.[41]

Each of these groups adopt the following transformation formula:

$$R_{inc} = R_{exc} \times \left(\frac{1-\tau(1-\gamma)}{1-\tau} \right) \qquad (13)$$

where

R_{inc} is the market rate of return on equity *inclusive* of the benefits of franking credits;[42]

R_{exc} is the market rate of return on equity *excluding* the benefits of franking credits;

τ is, again, the company tax rate of 30 per cent; and

γ is the assumed value for gamma.

It is therefore possible to adjust these DGM studies to the gamma value assumed in the regulatory decision. For example, the SFG (May 2015) study estimated a return on the market of 11.37 per cent (ie, 2.55 per cent plus 8.82 per cent). This market return on equity was based on a gamma value of 0.25.[43] Using the formula

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[39] ERA, DBP decision, p. 113.

[40] SFG, *The required return on equity for regulated gas and electricity network businesses | Report for Jemena Gas Networks, ActewAGL Distribution, Ergon and Transend*, 27 May 2014, p. 73.

[41] *Op. cit.*

[42] Note that here the returns are *rates* of return.

[43] SFG Consulting, *Updated estimate of the required return on equity | report for SA Power Networks*, 19 May 2015, p. 4.

(13) above the 11.37 per cent market return on equity can be adjusted to be consistent with a gamma value of 0.40 by:

- calculating the market return on equity *excluding* the benefits of franking credits under SFG's assumption that gamma equals 0.25:

$$R_{exc} = R_{inc} \times \left(\frac{1-\tau(1-\gamma)}{1-\tau}\right) = 11.37\% \times \left(\frac{1-0.30}{1-0.30\times(1-0.25)}\right) = 10.27\% \qquad (14)$$

- and then calculating the market return on equity *inclusive* of the benefits of franking credits under the ERA's assumption that gamma equals 0.40:

$$R_{inc} = R_{exc} \times \left(\frac{1-\tau(1-\gamma)}{1-\tau}\right) = 10.27\% \times \left(\frac{1-0.30\times(1-0.40)}{1-0.30}\right) = 12.03\% \qquad (15)$$

This results in an MRP of 9.48 per cent with a risk-free rate of 2.55 per cent. A similar adjustment to the Frontier Economics estimate results in an MRP of 9.00 per cent with a risk-free rate of 2.85 per cent.

Decisions by the AER include estimates of the MRP using DGM analysis. However, while the AER adopts the same DGM formula as the ERA, the AER's specification of the model differs in the following respects:[44]

- the AER considers estimates derived from both two-stage and three-stage DGMs with:
  - the two-stage DGM using three years of Bloomberg dividend forecasts with all subsequent years adopting the AER's long-run dividend growth assumption (mirroring the ERA's model); and
  - the three-stage DGM using three years of Bloomberg dividend forecasts followed by a 7-year glide path from the Bloomberg short-term dividend growth forecasts to the AER's long-run dividend growth rate which is assumed to apply in all subsequent periods;
- the AER considers a range of long-term dividend growth assumptions, for example, for AusNet Services distribution decision it considers 3.8, 4.6 and 5.1 per cent long-term growth rates;
- the AER uses Bloomberg data pricing and dividend forecasts for the S&P/ASX 200;
- the AER averages pricing and dividend forecasts over a two-month period;
- the AER calculates the MRP as the difference between the market return on equity and the 10-year risk-free rate; and
- the AER applies a theta value of 0.60 together with a company tax rate of 30 per cent and assumes that 75 per cent of dividends are franked.

It is relatively straight forward to update the AER's DGM estimates of the MRP using a theta value of 0.53. For example, in the AusNet Services distribution serviced decision cited in Table 6 of the DBP decision, the AER uses data for the two-month period ending at the end of December 2015 together with its assumptions about long-term dividend growth and a value for theta of 0.60 results in the estimates of the MRP that appear in Table 6.[45]

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[44] AER, *Final Decision | AusNet Services distribution determination 2016-2020 | Attachment 3 – Rate of return*, May 2016, pp. 226-2286.

[45] AER, *Final Decision | AusNet Services distribution determination 2016-2020 | Attachment 3 – Rate of return*, May 2016, p. 224.

Table 6: DGM estimates of the MRP, in per cent, that use the method employed by the AER in its AusNet Services distribution decision: Theta = 0.60

Growth rate	Two stage model	Three stage model
3.8	7.57	7.90
4.6	8.36	8.41
5.1	8.84	8.80

Source: Bloomberg data (November – December 2015), HoustonKemp analysis.

The DGM analysis that uses the AER's method and a value for theta of 0.60 indicates that for the two-month period up to the end of December 2015, a forward looking MRP ranges between 7.57 to 8.84 per cent.

Adopting a theta value of 0.53 rather than 0.60 lowers estimates of the MRP that use the AER's method. Table 7 reports estimates of the MRP that use data for the two-month period ending at the end of December 2015 and a value for theta of 0.53. With this lower value for theta, DGM estimates of the MRP that use the AER's method result in a range of 7.44 to 8.70 per cent.

Table 7: DGM estimates of the MRP, in per cent, that use the method employed by the AER in its AusNet Services distribution decision: Theta = 0.53

Growth rate	Two stage model	Three stage model
3.8	7.44	7.61
4.6	8.21	8.25
5.1	8.70	8.66

Source: Bloomberg data (November – December 2015), HoustonKemp analysis.

Table 8 collects together the MRP estimates we produce that use gamma or theta values consistent with the ERA's decision to adopt a value for gamma of 0.40 and value for theta of 0.53.

Table 8: Recalculated MRP estimates using the DGM in the ERA's DBP decision, June 2016 (using a consistent gamma/theta value)

Study/Author	Date	ERA Decision Implied MRP (%)	Consistent gamma/theta
SFG	May 2015	8.82	9.48
Frontier Economics	July 2015	8.35	9.00
AER	May 2016	7.57 – 8.84	7.44 – 8.70
ERA	May 2016	8.12	8.12
Estimated range of the MRP consistent with a gamma/theta		**7.6 – 8.8**	**7.4 – 9.5**

4.2.3 Estimate the MRP relative to the five-year risk-free rate

We also note each of the non-ERA DGM studies cited in the DBP decision calculate the MRP as the difference between the market return on equity and a 10-year risk-free rate. The ERA, however, calculates the MRP as the difference between the market return on equity and the five-year risk-free rate.

Adjusting the DGM estimates cited in the DBP decision for differences between the five-year and 10-year risk-free rates results in the estimates that appear in the last column of Table 9Table 9 below. Adjusting the DGM estimates results in an MRP range of 8.0 to 9.9 per cent per annum.

Table 9: Recalculated MRP estimates using the DGM in the ERA's DBP decision, June 2016 (using a consistent gamma/theta value and five-year risk-free rate)

Study/Author	Date	Decision Implied MRP (%)	Consistent gamma/theta	Consistent gamma/theta & Rf
SFG	May 2015	8.82	9.48	9.90
Frontier Economics	July 2015	8.35	9.00	9.57
AER/HoustonKemp	May 2016	7.57 – 8.84	7.44 – 8.70	8.03 – 9.29
ERA	May 2016	8.12	8.12	8.12
Estimated range of the MRP consistent with a gamma/theta		**7.6 – 8.8**	**7.4 – 9.5**	**8.0 – 9.9**

4.3 Recent DGM studies

The June 2016 DBP decision had regard to three recent DGM studies in addition to the analysis undertaken by the ERA. In Table 10 we use more recent estimates of the MRP provided by the AER as well as our update of the estimate provided by the ERA. We note that SFG/Frontier Economics have not updated their

DGM studies of the MRP and the mid-2015 studies will be over two years out of date by the time of any draft decision. These studies have not been included in our table of recent DGM studies of the MRP, however if updated, these studies would remain relevant recent estimate of the MRP using a DGM approach.

Recent estimates of the MRP using a DGM approach are set out in Table 10. These estimates have been adjusted for differences in assumptions made about theta and that are relative to the five-year risk-free rate. The MRP range using recent DGM studies is 7.0 and 8.2 per cent per annum.

Table 10: Updated MRP estimates using the DGM, May 2017 (using a consistent gamma/theta value and five-year risk-free rate)[46]

Study/Author	Date	Decision Implied MRP (%)	Consistent gamma/theta	Consistent gamma/theta & Rf
AER	April 2017	6.49 – 7.72	6.39 – 7.63	6.98 – 8.21
ERA	23 May 2017	7.93	7.93	7.93
Estimated range of the MRP consistent with a gamma/theta		**6.5 – 7.9**	**6.4 – 7.3**	**7.0 – 8.2**

4.4 Conclusion on DGM studies

The ERA's current approach to establishing an upper bound for the MRP is to use a DGM estimate drawn from a range of recent studies that includes the ERA's own work.

In this section, we update the ERA's analysis of DGM studies by:

- providing a prevailing MRP estimate using the ERA's two-stage DGM; and
- using the most recent DGM estimate of the MRP produced by the AER, from its final decision for TasNetworks in April 2017.

As set out in Table 10, this results in a range for the MRP of 6.5 to 7.9 per cent. However, this range uses assumptions that are inconsistent with the ERA's determination of theta/gamma and the ERA's use of a five-year risk-free rate. Adjusting the range for these differences results in an MRP range of 7.0 to 8.2 per cent.

We note the ERA adopts the highest MRP estimate from a range of recent DGM studies as its upper bound for the MRP. Applying this approach results in an upper bound for the MRP of 8.2 per cent.

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[46] AER, *TasNetworks distribution determination 2017-19 | Final decision | Attachment 3 – rate of return*, 28 April 2017 p.222.

5. Forward Looking Indicators of the MRP

The ERA in its DBP decision was guided by four forward looking indicators in choosing a point estimate for the MRP from within its range for the parameter. This approach necessarily involves a high degree of judgement and regulatory discretion, and is in our opinion an area that warrants further development by the ERA.

In this section, we:

- comment on the effectiveness of the four indicators currently used by the ERA;
- suggest additional indicators that would help the ERA determine a point estimate of the MRP from within its range for the parameter; and
- outline our preferred approach to using forward looking indictors of the MRP, which is to use combinations of indicators as predictors of the MRP – we note that this would require a substantial change in the approach employed by the ERA to set the MRP.

5.1 ERA’s indicators

The four indicators that the ERA currently use are:

- a measure of the default spread;
- the dividend yield on the All Ordinaries Index;
- the five-year interest-rate swap spread; and
- a volatility index.

To begin with, we provide an analysis of what the literature has to say about the effectiveness of each of these indicators in tracking variation in the MRP through time.

5.1.1 Default spread

The ERA calculates the default spread as the difference between the five-year yield from the AA Australian Corporate Bloomberg Fair Value Curve and the yield on a five-year Commonwealth Government Bond.

The default spread will tend to be high when times have been poor, that is, when growth rates of output have been persistently low. Fama (1991) argues that:[47]

> Persistent poor times may signal low wealth and higher risks in security returns, both of which can increase expected returns

and notes that: [48]

> returns for short and long horizons are predictable from … default spreads of low- over high-grade bond yields.

Figure 2 plots the default spread measured as the difference between the five-year yield from the AA Australian Corporate Bloomberg Fair Value Curve and the yield on a five-year Commonwealth Government Bond – along with the interest-rate swap spread – against time. Figure 2 makes clear that, relative to its recent history, the default spread is neither high nor low. The spread at

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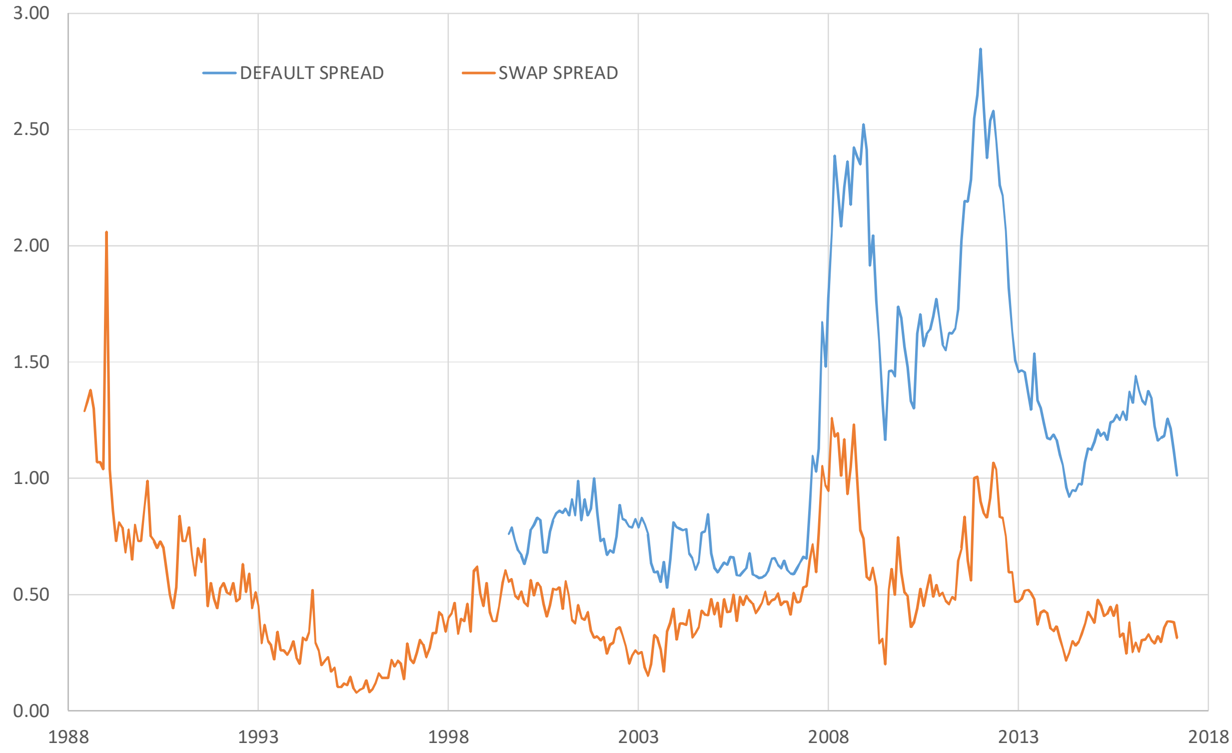
[47] Fama, *Efficient capital markets*, Journal of Finance 46, 1991, pp. 1575-1617.

[48] The evidence to which Fama refers includes evidence that returns to stocks in excess of the risk-free rate are predictable from default spreads.

the end of March 2017 is 101 basis points while the sample mean and standard deviation of the spreads from August 1999 to March 2017 are 120 and 57 basis points. Thus there is little evidence from the behaviour of the default spread that the MRP currently lies above the average level at which it has sat over the last 20 years or so.

Figure 2: Default spread and interest-rate swap spread



Notes: The figure uses end-of-month data. The default spread is the difference between the five-year yield from the AA Australian Corporate Bloomberg Fair Value Curve (Bloomberg code C3585Y) and the yield on a five-year Commonwealth Government Bond (taken from the Reserve Bank of Australia files f02d.xls and f02dhist.xls available at http://www.rba.gov.au/statistics/tables/#interest-rates and http://www.rba.gov.au/statistics/historical-data.html). The interest-rate swap spread is the difference between the five-year interest-rate swap rate (Bloomberg code ADSWAP5) and the yield on a five-year Commonwealth Government Bond.

5.1.2 Dividend yield

The ERA uses as a measure of the dividend yield on the market portfolio, the ASX All Ordinaries Analyst Consensus Dividend Yield.

The dividend yield on a stock or portfolio is the ratio of the dividends paid by the stock or portfolio to its price. If expected returns are high, then, all else constant, prices will be low. If prices are low, then, all else constant, dividend yields will be high. Thus one might expect to see a positive association between dividend yields and returns. In other words, if returns are to some extent predictable, then dividend yields may be good candidates for predictors of returns.

Campbell and Yogo (2006) conduct efficient tests of predictability that correct for small-sample bias and they find, after correcting for the bias, that there is evidence that dividend yields predict the return to the market portfolio in excess of the risk-free rate. [49]

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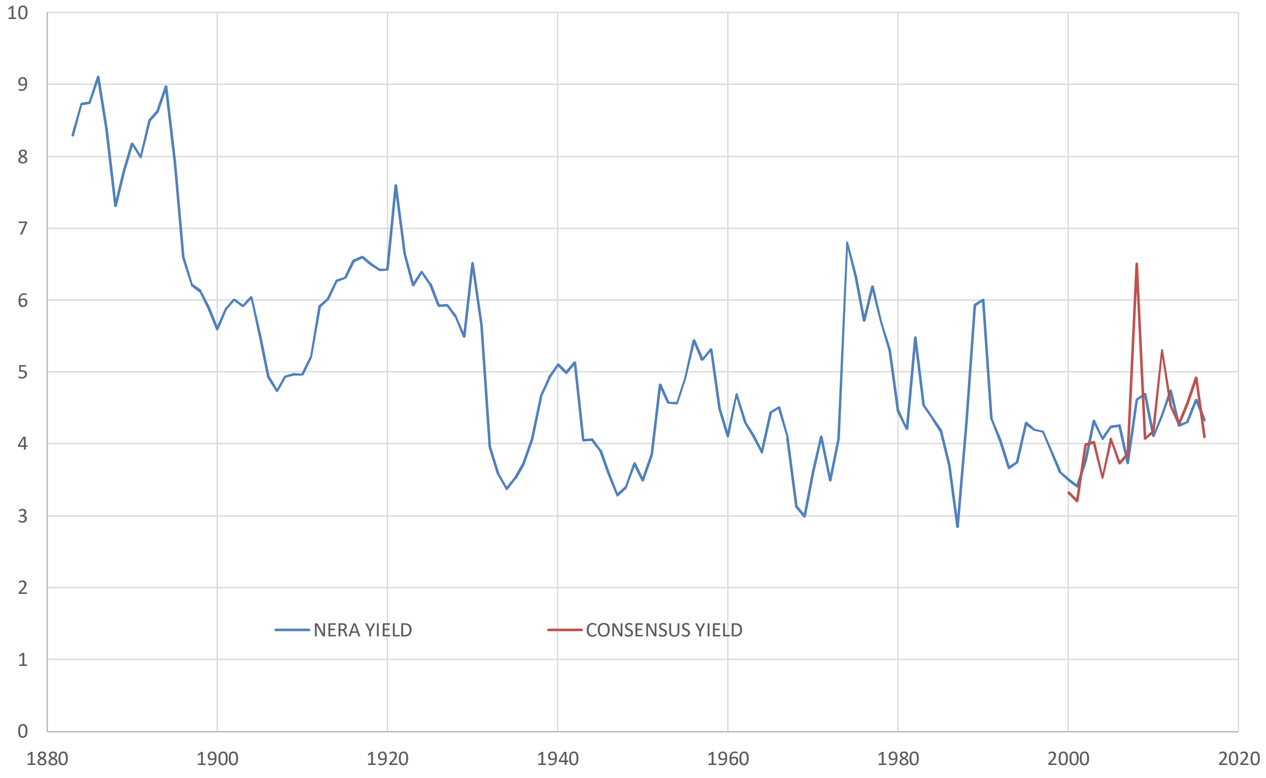
[49] Campbell, J. Y., and M. Yogo, *Efficient tests of stock return predictability*, Journal of Financial Economics, 2006, pp. 27–60.

Figure 3 plots the ERA's preferred measure of the dividend yield, the ASX All Ordinaries Analyst Consensus Dividend Yield (Bloomberg code EQY_DVD_YLD_12M), against time and also a measure of the dividend yield constructed from the annual series that we construct using the data that Brailsford, Handley and Maheswaran (2012), NERA (2013) and NERA (2015) provide. [50]

Figure 3: Dividend yield



Notes: The figure uses end-of-year data. The Bloomberg yield is the ASX All Ordinaries Analyst Consensus Dividend Yield (Bloomberg code EQY_DVD_YLD_12M). The NERA yield is computed from the annual data that we assemble that uses the adjustment factors that we compute from the data that Brailsford, Handley and Maheswaran and NERA (2013, 2015) provide.

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, pp. 237-247.

NERA, Market, size and value premiums: A report for the ENA, June 2013.

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

NERA, Further assessment of the historical MRP: Response to the AER's final decisions for the NSW and ACT electricity distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy, June 2015.

Figure 3 makes clear that, relative to its history, the dividend yield is neither high nor low. The Consensus yield at the end of 2016 is 4.09 per cent while the sample mean and standard deviation of the yield from

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[50] What we label the 'NERA yield' provides only a rough measure of the dividend yield since in constructing annual with-dividend returns we and Brailsford, Handley and Maheswaran reinvest dividends that are distributed within a year.

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, pp. 237-247.

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

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

NERA, *Further assessment of the historical MRP: Response to the AER's final decisions for the NSW and ACT electricity distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015.

2000 to 2016 are 4.25 per cent and 0.79 per cent. The NERA yield at the end of 2016 is 4.33 per cent while the sample mean and standard deviation of the yield from 1883 to 2016 are 5.16 per cent and 1.45 per cent. Thus there is little evidence from the behaviour of these two measures of the dividend yield that the MRP currently lies above the average level at which it has sat over the past.

5.1.3 Five-year interest-rate swap spread

The ERA calculates the five-year interest-rate swap spread as the difference between the five-year interest-rate swap rate and the yield on a five-year Commonwealth Government Bond. The swap spread is an alternative measure of the default spread.

Figure 2 plots the swap spread measured as the difference between the five-year interest-rate swap rate (Bloomberg code ADSWAP5) and the yield on a five-year Commonwealth Government Bond – again, along with the default spread – against time. Figure 2 makes clear that, relative to its recent history, the swap spread is neither high nor low. The spread at the end of March 2017 is 31 basis points while the sample mean and standard deviation of the spreads from June 1988 to March 2017 are 48 and 26 basis points. Thus there is little evidence from the behaviour of the swap spread that the MRP currently lies above the average level at which it has sat over the last 30 years or so.

5.1.4 Volatility index

Intuition suggests that risk and return must be related not just across assets but also across time. Merton (1973) shows that the conditions which allow the CAPM to hold instant by instant are also the conditions which guarantee that a simple relation exists between the MRP and the volatility of the return to the market portfolio.[51,52] This simple relation states that the MRP will be higher the more averse to risk is a representative investor and the more volatile is the return to the market portfolio. The evidence for a positive relation between the MRP and return volatility through time – like the evidence for a positive relation between mean return and beta across assets – is weak.

Tests for a link between the MRP and return volatility often employ volatility forecasts that have been backed out of option prices. These measures are called implied volatilities. They are typically generated using a version of the Black-Scholes option pricing model and at-the-money calls or puts. The evidence indicates that these implied volatilities have attractive properties.

Blair, Poon and Taylor (2001), for example, find that there is a positive relation between implied volatility and future volatility and that implied volatility better forecasts future volatility than other measures. They state that:[53]

> The in-sample estimates show that nearly all relevant information is provided by the VIX index and hence there is not much incremental information in high-frequency index returns. For out-of-sample forecasting, the VIX index provides the most accurate forecasts for all forecast horizons and performance measures considered.

The VIX is the ticker symbol for the Chicago Board Options Exchange Market Volatility Index, a measure of the implied volatility of the S&P 500 index.

Guo and Whitelaw (2006) also report the same sort of results. [54] They conclude that:[55]

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[51] The conditions are that either it is not possible to hedge against changes in the investment opportunity set or that a representative investor does not wish to do so.

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

[53] Blair, B., Poon, S.-H., and Taylor, S. (2001), "Forecasting S&P 500 Volatility: The Incremental Information Content of Implied Volatilities and High-Frequency Index Returns," *Journal of Econometrics*, 105, 5–26.

[54] Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, Journal of Finance, 2006, pp. 1433-1463.

[55] Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, Journal of Finance, 2006, p. 1446.

> it is clear that implied variance is the best single predictor [of realized volatility] and that little is lost by excluding the other explanatory variables. Consequently, we select the implied variance as the single explanatory variable in the variance equation.

The fact that implied volatility provides an upwardly biased forecast of future volatility, while of interest, need not generate a significant problem for forecasting if forecasts of future volatility can be adjusted for the bias. Guo and Whitelaw (2006), for example, adjust for the bias. They state that:[56]

> If implied variance is a conditionally unbiased predictor of future variance, then in Table I the intercept in the last regression should be equal to zero and the coefficient on implied variance should be equal to one. However, an extensive literature documents positive intercepts and slopes less than unity in similar regressions ... Table I shows that while the estimated coefficient is positive, it is significantly less than one, and the intercept is significantly positive, although it is small. Thus, while implied volatility may be informationally efficient relative to other variables it is not conditionally unbiased. As a result, we use the fitted value from this estimation as our proxy for conditional variance in the estimation of the full model.

Guo and Whitelaw also find a positive but insignificant relation between the MRP and implied volatility. For example, using the VIX as a measure of risk and data from 1984 through 2001 summarize their results in the following way: [57]

> Model 1 is the standard risk-return model estimated in much of the literature, that is, a regression of returns on a measure of the conditional variance. However, in contrast to many existing results, we find a coefficient that is positive, albeit statistically insignificant, and reasonable in magnitude. If the hedge component is unimportant or orthogonal to the risk component, the coefficient value of 2.5 represents an estimate of the coefficient of relative risk aversion of the representative agent; however, this estimate may be biased downwards slightly due to measurement error in the conditional variance.

Banerjee, Doran and Peterson (2007), on the other hand, using data from 1987 through 2005 find a significant positive relation between the VIX and future S&P 500 returns in excess of the risk-free rate.[58] The difference between the results of Guo and Whitelaw (2006) and Banerjee, Doran and Peterson (2007) must stem from their use of different time periods because there is little difference in the specifications that they use. Despite the difference between the results, the two pieces of evidence, particularly the second piece of evidence, suggest that there is some support for a link between the MRP and a measure of implied volatility. While this may be true, however, it is unclear whether implied volatility provides information not already contained in DGM estimates of the MRP.

The ERA uses the S&P/ASX 200 VIX as a measure of the volatility of the market portfolio implied by option prices and Figure 4 below plots the VIX against time. Like the ERA, we splice together two series:

- The Citigroup volatility index, CITJAVIX, taken from Bloomberg; and
- the S&P/ASX 200 VIX, taken from S&P's web page. [59]

A glance at the figure indicates that the level of the S&P/ASX 200 VIX is low relative to its history over the last 20 years or so. The VIX on 5 June 2017 is 12.14 per cent while the sample mean and standard deviation of the CITJAVIX and VIX together from 1 January 1997 to 5 June 2017 are 19.26 per cent and 8.07 per cent. Thus there is little evidence from the behaviour of the S&P/ASX 200 VIX that the MRP currently lies above the average level at which it has sat over the last 20 years. The weight placed on this evidence, however, should be tempered by the knowledge that the evidence for a positive relation between the MRP and implied volatility is weak.

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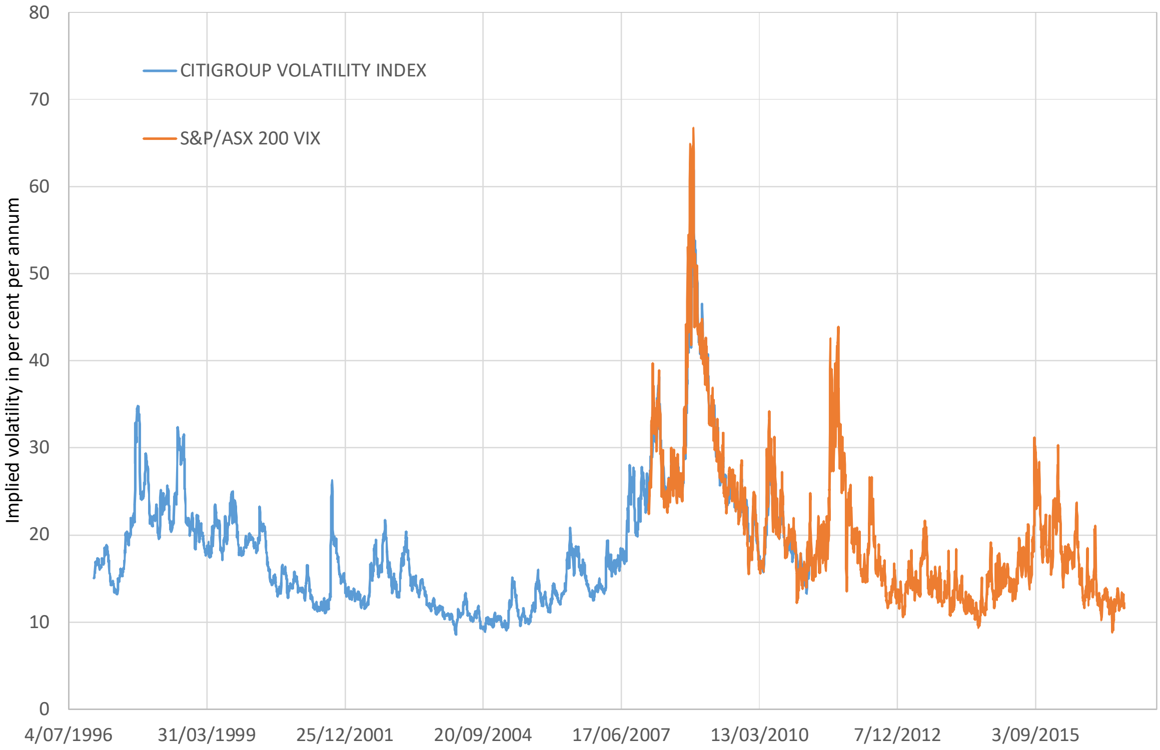
[56] Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, Journal of Finance, 2006, p. 1446.

[57] Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, Journal of Finance, 2006, p. 1448.

[58] Doran, J., P. Banerjee and D. Peterson, Implied volatility and future portfolio returns, Journal of Banking and Finance, 2007, pp. 3183–3199.

[59] https://au.spindices.com/indices/strategy/sp-asx-200-vix.

Figure 4: Implied volatility



Source: Bloomberg and S&P.

5.2 Other indicators

The literature also suggests that other indictors can be useful in tracking variation in the MRP through time.

5.2.1 Bill rate

There is evidence that indicates that there is a negative relation between the MRP and the return on a one-month or three-month bill.

Fama (1981) suggests that a negative association between bill rates and the expected returns on stocks is consistent with the predictions of the quantity theory of money and an accelerator theory of investment. [60] The quantity theory of money implies that, all else constant, inflation and output growth should be negatively related. An accelerator theory of investment suggests that expectations of higher output growth will trigger an increase in investment and raise the return required on capital. Thus if the quantity theory of money and an accelerator theory of investment are correct, an increase in expectations of economic growth will simultaneously lower expected inflation – and so lower bill rates – and raise the return required on capital and the expected returns on stocks. [61]

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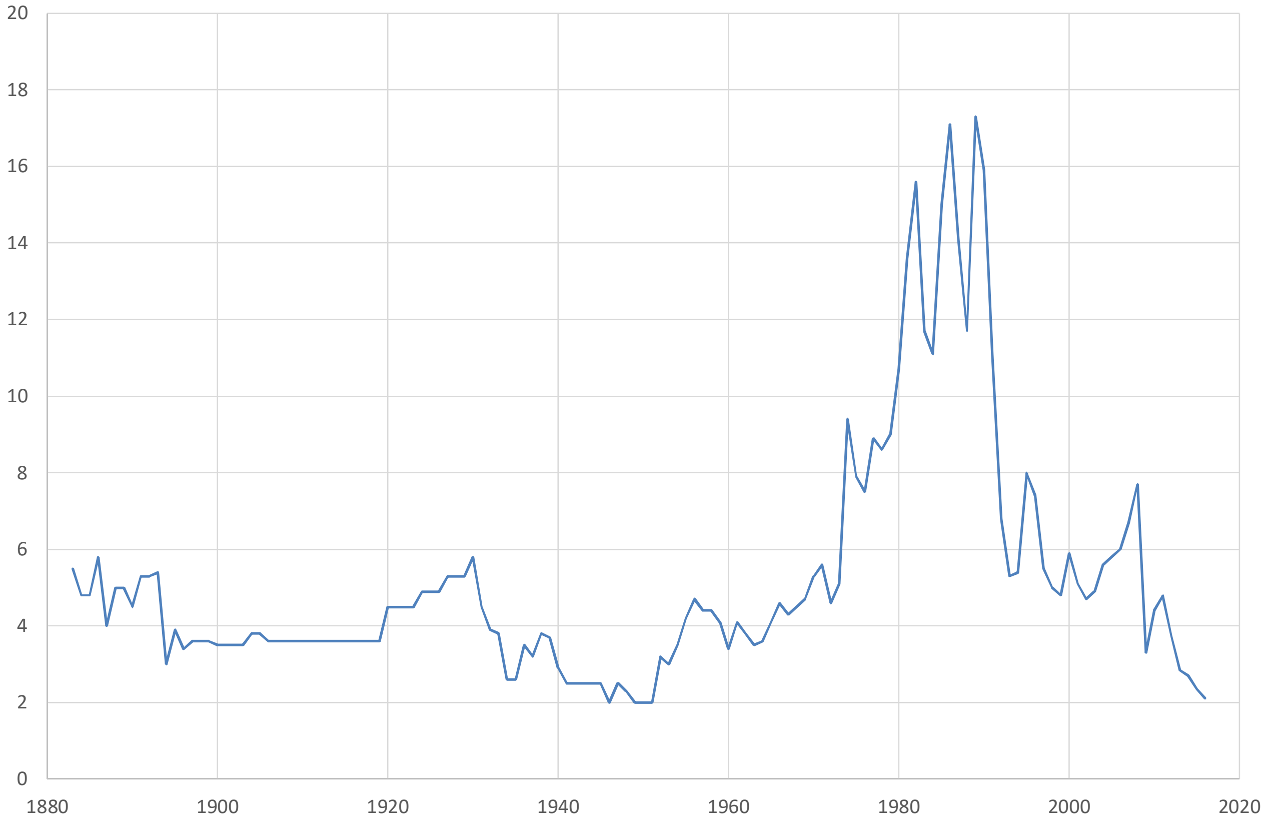
[60] Fama, E. F., *Stock returns, real activity, inflation, and money*, American Economic Review, 1981, pp. 545-565.

[61] Note that if expectations of inflation are high, investors will require a higher rate on bills, all else constant, whereas if expectations of inflation are low, investors will accept a lower rate on bills. Thus bill rates will reflect expectations of inflation.

Campbell and Yogo (2006) find that there is evidence that the bill rate can predict the return to the market portfolio in excess of the risk-free rate in US data while Hjalmarsson (2010) finds that the bill rate can predict the excess return to the market portfolio in data from 24 developed countries. [62]

Figure 5 plots the end-of-year three-month bill rate, using data from Brailsford, Handley and Maheswaran (2012) and the RBA, against time. [63] It is evident that the bill rate lies well below its long-run mean. The bill rate at the end of 2016 is 2.11 per cent while the sample mean and standard deviation of the rate from 1883 to 2016 are 5.21 per cent and 3.13 per cent. Thus there is some evidence from the behaviour of the bill rate that the MRP currently lies above the average level at which it has sat in past years.

Figure 5: Bill rate



Source: RBA and

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.

5.2.2 Wright method

The approach to estimating the MRP advocated by Wright of Birbeck College, the University of London, allows for a negative relation between the MRP and the bill rate. Although the ERA does not place a weight

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[62] Campbell, J. Y., and M. Yogo, *Efficient tests of stock return predictability*, Journal of Financial Economics, 2006, pp. 27–60.

Hjalmarsson, E., *Predicting global stock returns*, Journal of Financial and Quantitative Analysis 45, 2010, pp. 49-80.

[63] 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, pp. 237-247.

on the approach, UK regulators and their advisers give material weight to estimates of the MRP generated by the Wright approach.[64]

The Wright approach presumes that the mean real return to the market is comparatively stable implying that the MRP can be comparatively unstable. With the approach, a forecast of the MRP is generated as:

$$(1+\bar{r}_M)(1+\mathrm{E}(\pi))-1-R_f \tag{16}$$

where

$\bar{r}_M$ is an estimate of the mean real rate of return to the market produced from historical data;

$\mathrm{E}(\pi)$ is a forecast of inflation going forward; and

R_f is the nominal risk-free rate of return.

Using data from 1883 to 2016 an estimate of the mean real rate of return to the market is 8.93 per cent per annum – where we assume that theta is 0.53. A forecast of inflation generated by comparing the yields on nominal and indexed bonds over the 20 days ending on 23 May 2017 is 1.65 per cent per annum while the average five-year CGS yield over the 20 days ending on 23 May 2017 is 1.88 per cent per annum.

It follows that an estimate of the MRP that uses the Wright method – and so allows for a negative relation between the MRP and the bill rate – is, in per cent per annum:

$$100\times\left((1+0.0893)(1+0.0165)-1-0.0188\right)=8.85 \tag{17}$$

This estimate lies above the lower bound for the MRP produced from an analysis of past returns to the market portfolio in excess of the risk-free rate but lies within the range produced from estimates of the MRP that use the DGM.

5.2.3 Independent expert reports

Independent expert reports are an attractive source for gauging what values for the MRP practitioners are currently using. This is because:

- independent expert reports are typically made public;
- independent expert reports are often a requirement;
- independent experts face strong incentives to provide accurate responses;
- independent experts generally state whether they place a value on imputation credits; and
- independent experts generally state how they choose a value for the risk-free rate.

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.

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[64] See, for example:

Wright, S. and A. Smithers, *The cost of equity capital for regulated companies: A review for Ofgem*, Birbeck College, University of London, 2014.

In a January 2016 report for a number of regulated energy businesses we note that independent experts have in the recent past viewed uplifts to the MRP and the risk-free rate as alternative ways of raising the cost of capital for a firm to reflect the heightened risk that they see in the current environment.[65]

For example, we find three expert reports in which KPMG chooses a risk-free rate that differs by at least 100 basis points from the 10-year Commonwealth Government Security (CGS) yield. The first of these was published on 24 September 2012. In this report, KPMG states that:[66]

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

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

To determine the effective MRP that an expert uses in practice, one must determine what return the expert would require on an asset that has a beta of one and subtract from this return the contemporaneous CGS yield – where the contemporaneous CGS yield may differ from the risk-free rate that the expert employs. In a May 2016 report, Frontier computes the effective MRP in this way for four recent reports by four different experts. We report the results of this exercise below in Table 11. The values for the effective MRP sit above the lower bound produced by the mean of a series of excess returns to the market portfolio, which we construct in Section 3, but below the Wright estimate that we produce above – which in turn, again, lies within the range produced from estimates of the MRP that use the DGM.

We note, however, that the estimates in Table 11 exclude a value assigned to imputation credits distributed. To take into account the value of credits distributed, we multiply a forecast of the dividend yield, measured as the ratio of dividends to start-of-year price, on the market portfolio by:

$$0.53 \times 0.75 \times \left(\frac{0.30}{1-0.30} \right) = 0.1704 \tag{18}$$

Here we assume that theta is 0.53, the proportion of dividends that are franked is 75 per cent and that the corporate tax rate is 30 per cent. The average dividend yield, measured as the ratio of dividends to start-of-year price, over the period 1883 to 2016, computed from the data that we assemble using the adjustments that NERA (2013, 2015) provides and the data that Brailsford, Handley and Maheswaran (2012) supply is

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[65] HoustonKemp, *The cost of equity: Response to the AER's Draft Decisions for the Victorian electricity distributors, ActewAGL Distribution and Australian Gas Networks: A Report for ActewAGL Distribution, AusNet Services, Australian Gas Networks, CitiPower, Jemena Electricity Networks, Powercor and United Energy*, January 2016.

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

5.46 per cent.[67] Thus an adjustment of the value arising from the distribution of imputation credits based on this average yield in per cent per annum is:

$$0.1704 \times 5.46 = 0.93 \tag{19}$$

It follows that including a value for imputation credits distributed raises the estimates of the MRP provided in Table 11 by 93 basis points but does not alter the conclusions that we draw above.

Table 11: The effective MRP, in per cent per annum, used in recent independent expert reports

Expert	Report date	Company	Required market return	Contemporaneous bond yield	Effective MRP
Lonergan Edwards	31/3/2016	Ethane Pipeline Fund	10.0	3.1	6.9
Grant Samuel	20/5/2016	Pacific Brands	11.2	2.5	8.7
Deloitte	15/7/2016	Patties Foods	9.6	1.8	7.8
KPMG	29/2/2016	STW Communications	10.4	2.4	8.0

Source: Frontier, Recent evidence on the market risk premium: Final report for Aurizon Network, May 2017, pages 8-9.

5.3 Indicator combinations

Welch and Goyal (2008) examine the ability of a number of variables, including dividend yields, to predict the excess return to the market portfolio and find variables that are able to predict returns in sample are typically unable to predict returns out of sample.[68] Their work casts some doubt over whether it is possible to forecast the MRP but there have been a number of responses to their work that suggests that such a conclusion is not warranted.

Campbell and Thompson (2008) find, for example, that many predictive regressions beat the historical sample mean return once weak restrictions are imposed on the signs of coefficients and return forecasts.[69] Two restrictions that Campbell and Thompson impose are that the regression coefficient has the theoretically expected sign and that the fitted value of the MRP is positive. They find that simply by imposing these restrictions, they are able to substantially improve the out-of-sample performance of predictive regressions.

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[67] 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, pp. 237-247.

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

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

NERA, *Further assessment of the historical MRP: Response to the AER's final decisions for the NSW and ACT electricity distributors: A report for ActewAGL Distribution, AGN, APA, AusNet Services, CitiPower, Energex, Ergon Energy, Jemena Electricity Networks, Powercor, SA Power Networks and United Energy*, June 2015.

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

[69] Campbell, J. Y., and S. B. Thompson, *Predicting the equity premium out of sample: Can anything beat the historical average?* Review of Financial Studies, 2008, pp. 1509-1531.

Rapach, Strauss and Zhou find that while individual indicators may not be useful for predicting returns out of sample, combinations of indicators in US data are useful.[70] Duo, Gallagher, Schneider and Walter (2012) reach the same conclusion from an analysis of 15 indicators and Australian data.[71]

An approach that systematically examines the ability of a range of indicators, used together, to predict the return to the market portfolio in excess of the risk-free rate and is capable of providing a forecast of the MRP is to be preferred. Updating the work of Duo, Gallagher, Schneider and Walter, however, is beyond the scope of this report.

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[70] Rapach, D.E., J.K. Strauss and G. Zhou, Out-of-sample equity premium prediction: Combination forecasts and links to the real economy, Review of Financial Studies 23, 2010, pp. 821-862.

[71] Dou, Y., D. Gallagher, D.H. Schneider and T.S. Walter, Out-of-sample stock return predictability in Australia, Australian Journal of Management 37, 2012, pp. 461-479.

6. Conclusion

The ERA currently determines the MRP by the following two steps:

1. establish a range for the MRP using:
    i. estimates of the long-run average MRP computed from historical data to form a lower bound for the range; and
    ii. estimates from recent studies employing the DGM to form an upper bound for the range; and
2. determine a point estimate for the MRP from within the range using four forward looking indicators and its own judgement.

In section 3 of this report we update the ERA's table of the historical returns to the market portfolio in excess of the yield on a five-year government bond to include market data for 2016.

Table 12: Estimates of the MRP: Theta = 0.53

	Arithmetic			Geometric		
	BHM	NERA	Average	BHM	NERA	Average
1883-2016	6.41	6.77	6.59	5.05	5.40	5.22
	(1.42)	(1.42)	(1.42)	(1.50)	(1.51)	(1.51)
1937-2016	6.19	6.12	6.15	4.32	4.26	4.29
	(2.16)	(2.16)	(2.16)	(2.27)	(2.27)	(2.27)
1958-2016	6.61	6.61	6.61	4.25	4.25	4.25
	(2.83)	(2.83)	(2.83)	(2.98)	(2.98)	(2.98)
1980-2016	6.30	6.30	6.30	3.98	3.98	3.98
	(3.52)	(3.52)	(3.52)	(3.77)	(3.77)	(3.77)
1988-2016	5.78	5.78	5.78	4.12	4.12	4.12
	(3.25)	(3.25)	(3.25)	(3.70)	(3.70)	(3.70)

Notes: Estimates in per cent per annum are outside of parentheses and standard errors in per cent per annum are in parentheses. Standard errors for the geometric mean presume that one plus the excess return to the market is lognormally distributed. The MRP is computed, following the ERA, relative to the average of the three-month bill yield and 10-year bond yield.

The approach that the ERA currently uses is to employ simple averages of the estimates that it computes using the BHM and NERA data and, as a lower bound for the MRP, a simple average of the lowest arithmetic mean across the five periods that it considers and the highest geometric mean. Using this approach, a lower bound for the MRP would be a simple average of:

- the lowest arithmetic mean of 5.78 per cent (from the 1988-2016 period); and
- the highest geometric mean of 5.22 per cent (from the 1883-2016 period).

The ERA's current approach would result in a lower bound for the MRP of 5.50 per cent.

In section 3 of the report, we suggest a number of changes to the ERA's method of choosing a lower bound for the MRP which results in a lower bound of 6.77 per cent per annum. The changes that we recommend are that the ERA:

- place a sole reliance on the NERA data set consistent with the approach adopted by market practitioners such as Dimson, Marsh and Staunton;
- use the longest period available (1883-2016) to ensure an estimate of the MRP is as precise as possible; and
- place no weight on geometric mean estimates of the MRP to avoid introducing a downward bias into its estimate of the MRP.

In section 4 of this report we update the ERA's analysis of DGM studies by:

- providing a prevailing MRP estimate using the ERA's two-stage DGM; and
- using the most recent DGM estimate of the MRP produced by the AER, from its final decision for TasNetworks in April 2017.

Table 13: Updated MRP recently estimated using the DGM, May 2017 (using a consistent gamma/theta value and 5-year risk free rate)

Study/Author	Date	Decision Implied MRP (%)	Consistent gamma/theta	Consistent gamma/theta & Rf
AER[72]	April 2017	6.49 – 7.72	6.39 – 7.63	6.98 – 8.21
ERA	23 May 2017	7.93	7.93	7.93
Estimated range of the MRP consistent with a gamma/theta		**6.5 – 7.9**	**6.4 – 7.9**	**7.0 – 8.2**

The ERA's current approach would lead to a range for the MRP using recent DGM studies of 6.5 to 7.9 per cent. However, in section 4 of this report we highlight that these DGM studies adopt assumptions that are inconsistent with the ERA's determination for theta and gamma and its use of a 5-year risk-free rate. Adjusting estimates of the MRP produced by recent DGM studies results in the adjusted MRP range shown in the last column of Table 13 of 7.0 to 8.2 per cent. Adopting the ERA's approach of using the highest DGM estimate of the MRP from recent DGM studies results in an upper bound for the MRP of 8.2 per cent.

This results in a range for the five-year forward looking MRP of 6.8 to 8.2 per cent, with a midpoint of **7.5 per cent**.

Finally, section 5 of this report reviews the ERA's use of forward looking indicators for the MRP to determine a point estimate of the MRP from within the range that it constructs for the parameter. Our review finds that:

- there is some evidence for using default spreads, dividend yields and interest rate swaps as forward looking indicators for the MRP, with prevailing observations of each of these indicators close to average levels;
- the evidence for a positive relation between the MRP and implied volatility through time is weak, and so while the current level of the S&P/ASX 200 VIX is low relative to its history over the last 20 years, little weight should be placed on this observation;

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[72] AER, *TasNetworks distribution determination 2017-19 | Final decision | Attachment 3 – rate of return*, 28 April 2017 p.222.

- there are a number of indicators that the ERA should also include in its deliberations, including:
  - **the prevailing bill rate** – evidence of a negative relation between the MRP and the bill rate coupled with the observation that the bill rate currently lies well below its historical mean suggests that the MRP currently lies above the average level at which it has sat in past years;
  - **Wright's estimate of the MRP** – which currently lies at 8.85 per cent, which suggests that the midpoint of MRP range is a conservative estimate of the prevailing MRP; and
  - **values for the MRP drawn from independent expert reports** – these reports, prepared by accredited independent experts working within an explicit regime of regulation that requires that the experts be accountable for the results of their work, provide an indication of values for the MRP that practitioners are currently using; reports in 2016 indicate that experts are effectively using an MRP of between 7.8 and 9.6 per cent; and
- an approach that systematically examines the ability of a range of indicators, used together, to predict the return to the market portfolio in excess of the risk-free rate is, in our opinion, the preferred method for using forward looking indicators to set the point estimate of the MRP; however, adopting this approach would require a substantial change to the ERA's methodology.

A1. Bias associated with geometric mean

Define G to be the geometric mean of a sample of gross annual returns, that is, define:

$$G = \left[\prod_{t=1}^{T} R(t) \right]^{1/T} \tag{A.1}$$

and assume, in addition, that:

$$\ln(R(t)) \sim NID(\mu, \sigma^2) \tag{A.2}$$

where:

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

T = the number of observations.

Then the unconditional expectation of the geometric mean compounded over n periods will be:

$$\mathrm{E}(G^n) = \mathrm{E}\left(\exp\left(\frac{n}{T} \sum_{t=1}^{T} \ln((R(t)) \right) \right) = \exp\left(n\left(\mu + \frac{n}{2T}\sigma^2 \right) \right) \tag{A.3}$$

while

$$\mathrm{E}(R(t)) = \exp\left(\mu + \frac{1}{2}\sigma^2 \right) \tag{A.4}$$

so that

$$(\mathrm{E}(R(t)))^n = \exp\left(n\left(\mu + \frac{1}{2}\sigma^2 \right) \right) \tag{A.5}$$

It follows that if $n < T$, an estimator for the mean return to an asset that uses the geometric mean compounded over n periods will be biased downwards.

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