Report to the CRG: The Dividend Growth Model the MRP and the AER's 2022 Draft Rate of Return Instrument

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26 August 2022

Author’s Credentials

This report has been prepared by Graham Partington and Stephen Satchell. We have extensive experience as senior finance academics at the professorial level. Our experience covers finance, economics, econometrics, modelling, and forecasting. We have taught at universities around the world including Cambridge University and the University of Sydney. Our published work includes several finance books and over 200 research papers.

We are both experienced consultants who have undertaken extensive financial consulting in areas such as, investments, dividend imputation, valuation and the cost of capital. In respect to the particular issues in this report we note that we have previously provided advice to the AER on the use of dividend growth models and have published research on both the cost of capital and on dividends.

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Executive summary

Main questions

The questions that the CRG has asked are about:

- the potential variation in estimates of the MRP derived from the AER's 3-stage model;
- whether the AER's 3-stage model provides the best estimate of the DGM in the context of the AER's proposed use of the DGM in the 2022 RoRI, and
- whether the AER's approach to term is consistent with finance theory.

Variation in the MRP estimates

The potential variation in estimates of the MRP was the subject of additional detailed questions from the CRG. The answers to these questions occupy much of this report and involve some quite technical discussion. Looking at the historical estimates from 2006 to 2022 the range of variation in the MRP is about 7%, with the range varying slightly across the models examined. This gives a plausible range for variation in the AER's model. We caution however that this range could expand over time if inflation takes off and is expected to be sustained at a high level. Changes in inflation would lead to revisions in the assumed long term growth rate. This latter was held constant in forming the historical MRP estimates.

Via a strong negative correlation, variation in the market index drives the variation in the estimate of the implied return on equity from the DGM. This, as we explain, is a property of the DGM estimator, rather than reliable tracking of variation in the actual required return on equity. There is also a weak negative correlation between the MRP estimates for the three stage model and the market index, but not for the two stage model.

Using a three stage model or using the five year risk free rate tends to give higher estimates of the MRP, but the differences are usually not large. The estimated MRP is sensitive to variation in the level of the interest rates over time, but whether the five year rate or ten year rate is used will only give relatively small differences on average. Sensitivity of the MRP to analysts' forecasts of dividends is only modest. This, in part, is because the forecasts only contribute a rather minor component to the value of the index. The overwhelming bulk of the value of the index is accounted for by the terminal value assumption. This value in turn has a significant dependence on the assumed long term growth rate. Our analysis suggests that changes in the long term growth rate will cause a change in the MRP of only slightly less than the change in the growth rate. The lessons of history tell us that, due to inflation, changes in nominal growth rates can be large.

Choice of model

The selection of the best DGM model depends on the criterion for best. Our criterion would be accurately tracking variation in the MRP. Against this criterion we would not recommend any DGM model. Our report involves some specific criticism of the AER's model, and we explain why it is likely to give upward biased estimates. However, much of our criticism would apply to other DGMs. If a DGM model is to be used, the AER model is probably as good as any of the alternatives, since we do not expect any DGM model that we know of to reliably track the MRP. The estimates of the implied cost of equity from such models are likely to just give an inverse tracking of the market index.

The AER's DGM, as noted above, gives estimates of the rate of return on equity that have a negative relation with the level of the market index, and we show that the AER DGM model could be replaced with a simple linear regression equation. The negative relation is one that we generally expect from DGM estimates of the MRP because, for reasons that we explain in the body of the report, in practice DGM estimates attribute the great bulk of changes in market value to changes in the discount rate.

If stability of the allowed rate of return is a criterion of the desirability of the DGM model, then under the AER's option 3b a weighted average of the historic equity risk premium and the DGM MRP estimate is likely to bring more stability in allowed rates of return than the AER's current approach. For users with a preference for stability the two stage model may be slightly better. However, the reduction in volatility under option 3b is modest and could be lost if there are frequent and significant changes in the long term growth rate. In the body of the report, we point out that stability is not all benefits to consumers, it also has costs.

Whether the AER's three stage model is better than their two stage model or vice versa, depends on which model gives the better estimate of terminal value. We show that terminal value is the main component in the AER's models. Unfortunately, which model gives the most accurate terminal value is not known. Thus, the issue boils down to whether an assumption of a sharp jump to the steady state growth at year three is better than a linear adjustment of dividends out to year ten, when the steady state kicks in. Both have drawbacks, so the choice largely boils down to the users' preferences. Users favouring a higher MRP are more likely to favour the three stage model, which mostly, but not necessarily always, gives a slightly higher return. Users favouring a lower MRP will favour the two stage model.

The reason for this difference in estimates between the models is the incurable optimism bias. Almost invariably, applications of the DGM seem to have the current dividend growth rate falling towards the lower long run growth rate.[1] In which case the longer the period of adjustment to the steady state, the bigger the discount rate required to equate the present value of dividends to the current value of the market index.

Choice of Term

With respect to the selection of the horizon used in estimating the return on equity we conclude that the AER's decision to change to a five year term for this purpose is consistent with finance theory. However, we remain uneasy that this is a departure from standard industry practice in estimating the cost of equity. We also wonder whether the case for the change is high enough to clear the high bar to change that is advocated by the CRG.

[1] It is impossible for the current dividend growth rate to always be above the long term growth rate.

1. Introduction

General

The Consumer Reference Group (CRG) has approached us to provide advice on the use of dividend growth models (DGMs) in determining the market risk premium (MRP). That advice has been sought consequent to the publication of the AER's 2022 Draft Rate of Return Instrument. The CRG is particularly seeking advice on the possible variability of MRP estimates from the DGM, and also advice on the AER's option 3b to use a combination of the historic equity risk premium (HER) and the DGM MRP estimate. The CRG also asked for advice on whether the shift to a five year term for estimation of the allowed rate of return was consistent with finance theory. The full terms of reference for the request can be found at Appendix A.

We would like to acknowledge our very considerable gratitude for the help that we received from AER staff in providing information about the AER's DGM model, output from the model, and summary descriptive statistics on the model inputs. Their assistance was swiftly delivered, and queries were answered promptly. This greatly facilitated and simplified our task, and we would describe the assistance from AER staff as outstanding.

2. Upward bias in the DGM estimate of the MRP

There are many possible DGM models that might be used to generate an implied rate of return. The process in such models is to make some forecast of future dividends and then find the discount rate (implied rate of return) that equates the present value of the dividends to the current share price. When estimating the MRP, the objective is to find the implied rate of return that equates the present value of total dividends from the market with the current total value of the market. Deducting the current risk free rate (R_f) from the implied rate of return gives the MRP.

We have been very critical of the use of DGMs in estimating rates of return and the MRP, see for example, *Report to the AER: Alternative asset pricing models*, G. Partington and S, Satchell, June 2020. Since we have previously dealt with this at length and also since a general analysis of the DGM is not part of our terms of reference we will not focus our report on this issue. Some discussion, however, cannot be avoided as it goes to the properties of the estimates that we are examining. Several issues in implementing the DGM were discussed in the Independent Panel Report (2022) on the AER's Draft Rate of Return Instrument. They observe p.21:

> *Partington and Satchell conclude, page 64:*
>
> *'… we cannot recommend the DGM for use in estimating the regulated rate of return for individual firms. We conclude that the DGM has the potential to be relevant, but it is not reliable or suitable. Whether it is simple depends on the model implemented and with respect to practical use in estimating firms' cost of equity it seems to have failed the test of time.'*
>
> *We agree with Partington and Satchell's conclusion that the problems and difficulties of implementing the DGM make it of no practical use for the AER in estimating the regulated rate of return for individual firms.*

We would add that these problems spill over into using the DGM to estimate the MRP and some extra problems are added. We also draw particular attention to the high probability that the AER's DGM model will yield upward biased estimates of the MRP.

Upward bias

First, the model relies on analyst's forecasts of dividends. Analyst's forecasts are well known to be upward biased; dividend forecasts are less biased than earnings forecasts, but they are still upward biased. A higher forecast for dividends requires a higher discount rate to equate the present value of the dividends to the current price. Thus, an upward biased implied rate of return results and an upward biased implied rate of return gives an upward biased MRP.

Second, the AER's model does not use the total dividends from the market, or the total market value. The AER uses the ASX/S&P 200 price index[2] as a proxy for the total market. There are good pragmatic reasons for this,[3] however, this choice has consequences. The ASX/S&P 200 represents a small minority of firms by number (of the order of 9%) but a large majority of firms by value (in excess of 70%). Smaller companies, which often include start-ups, do not make it into the ASX/S&P 200. Small companies and start-ups often have profits that are zero, or small and/or unstable. Where there are profits, there are often strong pressures to reinvest those profits to fund growth. In short, the characteristics of many companies excluded from the ASX/S&P 200 are the characteristics of firms that do not currently pay dividends.[4] The converse is true for firms included in the ASX/S&P 200. Thus, as a measure of total dividends on the market the ASX/S&P 200 is upward biased.[5] Clearly, the exclusion of stocks with zero dividends from calculation of the implied rate of return would inflate the MRP and this is effectively the result of using the ASX/S&P 200 index.

A further concern is that the ASX/S&P 200 index is a downward biased measure of the market value of the stocks included in the ASX/S&P 200. This is because the index is designed to measure the return to investors from price changes and consequently, a component of S&P's "Divisor" adjustment, removes from the

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[2] There are several ASX/S&P 200 indices, price, total return, gross total return (accumulation), net total return (adjusted for withholding tax), dividend points, and franking credit adjusted indices. Hereafter, reference to the ASX/S&P 200 index is to the price index, reference to other versions of the ASX/S&P 200 index will be labelled as such.

[3] The ASX/S&P 200 is often said to cover the investable universe for institutional investors. Consequently, there is good coverage by analysts and thus forecasts of dividends are available for firms in the ASX/S&P 200. Such firms are also unlikely to have stale prices. Whereas, for firms excluded from the ASX/S&P 200 analysts' coverage is likely to be patchy and some stale prices are likely.

[4] It is probable that some of these firms will become substantial contributors to sustaining ASX dividends in the future.

[5] This situation is analogous to the incomplete coverage of firms in financial data bases, which as discussed in G. Partington, 2009, Discussion of an International Analysis of Dividend Payment Behaviour, *Journal of Business Finance and Accounting*, 36:3-4, pp. 523-529, leads to erroneous inferences regarding dividends.

index changes in market capitalisation arising from share issues.[6] Unless dividends are correspondingly adjusted, a higher implied discount rate would be required in order to equate the present value of dividends to the downward adjusted estimate of market capitalisation. The ASX/S&P 200 Dividend Points Indices do make a divisor adjustment. However, we are not aware of what adjustment, if any, that Bloomberg makes in its consensus forecast as used by the AER. Without an adjustment, the effect would be an overstatement of the MRP.

Another issue with the ASX/S&P 200 index is that the weightings in the index do not reflect the market value weights of the firms, but rather are adjusted according to S&P's calculation of the free float (extent of a firm's shares on issue readily available for trading). This adjustment is accomplished by an investible weight factor (IWF), which is defined for each firm as:

IWF = (available float shares)/(total shares outstanding)

Unless each firm's expected dividend is also weighted by the firm's IWF, it is not clear what relation exists between the value of the dividends and the value of the ASX/S&P 200 index.

Upward bias summary

The use of the ASX/S&P 200 index as a proxy for the market seems likely to result in an upward bias in the MRP. However, the extent of the upward bias is not known. This does not seem to be an easy issue to resolve. For example, expanding the coverage of firms to the ASX/S&P 300 index, might help, but could suffer from reduced coverage of firms by analysts. Expanding much beyond the ASX/S&P 300 would likely suffer from a shortage of dividend forecasts.

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[6] Such adjustments for capitalisation changes can be error prone, particularly in the case of rights issues, see H. Chu and G. Partington, 2001, Dangers in Data Adjustment: The Case of Rights Issues and Returns, *Accounting and Finance*, 41:2, pp.143-168.

One step that could be taken is to either work with total dividends and the total market capitalisation of the ASX 200 firms, or to make sure that dividends are adjusted to be consistent with the valuation of the ASX/S&P 200 index. A key question, therefore, is whether the Bloomberg consensus analyst forecast is adjusted and if so, exactly how.

In summary, an upward biased estimate of dividends combined with a downward biased estimate of market capitalisation is very likely to result in an upward biased estimate of the MRP. This outcome is not certain, however, because the outcome also depends on the estimate of the long term growth rate, the assumed path to steady state growth and any adjustments made to dividends to make them match the nature of the market index.

There are other potential sources of bias in MRP estimates derived from the DGM. Two of these, the measurement of dividends as gross or net dividends, and the adjustment of the long term growth rate for future share issues, are discussed later in this report.

3. Sensitivity analysis: The AER model and the plausible range of outcomes of the DGM calculation using historical data.

Timing assumptions and dividends

Most of the firms on the ASX that pay dividends, pay them twice yearly. There is a clustering of dividend payments about March (interim dividend) and another clustering about September (final dividend). The latter tends to be when changes to dividends are made and such changes are commonly zero or positive, since managers attempt to construct a stable but gradually increasing stream of dividends over time.

Ideally the DGM should be set up to reflect the twice yearly clustering of dividends, but the AER has forecasts of annual dividends for the calendar year, rather than interim and final dividends. Thus, in order to allow for dividends occurring during the year, rather than assuming an annual dividend being paid at year end, the AER has adopted a mid-year payment assumption for their DGM. However, as we discuss below, the result is an inconsistency in timing assumptions with respect to the first term of their model and also a pattern of bias in monthly estimates of the MRP.

The AER's model

Here we reproduce the formula given on page 142 of the AER's 2022 Draft Rate of Return Instrument: Explanatory Statement. We have corrected two typographical errors in the summation formula, replacing n by N in the upper summation and replacing *t* = 0 by *t* = 1 in the lower summation.

$$P_c = \frac{m\mathrm{E}(D_c)}{(1+k_c)^{m/2}} + \sum_{t=1}^{N} \frac{\mathrm{E}(D_t)}{(1+k_c)^{m+t-1/2}} + \frac{\mathrm{E}(D_N)(1+\mathrm{g})}{(k_c-g)(1+k_c)^{m+N-1/2}} \quad (1)$$

Where:

- P_c is the current price of equity, for which the S&P/ASX 200 index is used as the proxy
- E(D_c) is expected dividends per share for the current financial year c
- E(D_t) is expected dividends per share for the financial year, t years after the current financial year
- m is the fraction of the current financial year remaining, expressed as a decimal point
- N is the time period after which dividend growth reverts to its long-term rate (for the 2-stage model N = 2, for the 3-stage model N = 9)
- g is the expected long-term growth rate in nominal dividends per share.
- $k_c$is the expected return on equity for the market portfolio.

We query the first term in (1). Equation 1 is created on the assumption that dividends are paid half-way through the financial year. If $m \geq 0.5$, one would expect to receive $\mathrm{E}(D_c)$ in (m -1/2) years so the first term would be:

$$\frac{\mathrm{E}(D_c)}{(1+k_c)^{m-1/2}}$$

If m < 0.5, you would not receive the dividend, so the first term is zero. The correct form for the first term is in fact $\delta\ \frac{\mathrm{E}(D_c)}{(1+k_c)^{m-1/2}}$ where $\delta = 1$ if $m \geq 0.5$. And δ = 0 otherwise.

This allows us to write the formula

$$P_c = \frac{1}{(1+k_c)^{m-1/2}}\left(\mathrm{E}(D_c)\delta + \sum_{t=1}^{N}\frac{\mathrm{E}(D_t)}{(1+k_c)^t} + \frac{\mathrm{E}(D_N)(1+\mathrm{g})}{(k_c-g)(1+k_c)^N}\right) \tag{2}$$

The problem with the original model is incorrect assumptions based on algebraic error. To solve the consistency problem one solution is to use the corrected formula above. Another solution is to make all estimates of the market risk premium using as a focal date the start of the calendar year. In which case the first term of the model is not required, and the second term becomes a summation from zero to N. A third solution is to ditch the mid-year convention. A fourth solution is to assume a pattern of payment that matches the actual clustering of dividends twice a year Alternatively, the AER might argue that their assumption is that dividends are paid continuously and uniformly over the year and that they are using the average payment date for the dividends observed. In this case the AER would be assuming a continuous process for dividends but using discrete dividends in the model. The question that arises is whether their growth rate estimates should then be computed as continuous or discrete growth rates.

There is a second timing issue. Over the first half of the year, particularly from March onwards, there will be a large numbers of stocks trading ex-dividend (with respect to the interim dividend). A substantial majority of dividend paying stocks are likely to be ex-dividend by the end of April and, with the exception of a few special cases, all stocks will be trading ex-dividend by the end of June. The assumption in the DGM model, however, is that stocks in the first half of the year are trading cum-dividend. The result, for the first half of the year will be an increasing upward bias in the monthly estimates of the MRP from January to June. The reverse effect will arise in the second half of the year, where stocks will nearly all begin trading cum dividend (with respect to the final dividend), whereas the model assumes they will all be trading ex-dividend. Thus, networks will be advantaged, or disadvantaged, depending on the date of their rate of return determination. The materiality of this effect is an open question.

Most of these timing problems can be avoided by only forming MRP estimates in January and only for the full year. This eliminates *m* from the analysis. It also means that nearly all of the stocks will be trading cum-dividend. It could, however, expose the analysis to a January seasonal effect of rising prices.

Time series issues

It is worth noting that in the first period (t=1) and onwards, if we were doing this annually on July 1, we would use the formula,

$$P_j = \sum_{t=1}^{N} \frac{\mathrm{E}\left(D_{t+j}\right)}{(1+k_j)^t} + \frac{\mathrm{E}\left(D_{N+j}\right)(1+\mathrm{g})}{(k_j - g)(1+k_j)^N} \quad \text{for } j=1,\ldots,T, \qquad (3)$$

where T is the number of time-series values under consideration.

This has the further implication that from a time-series perspective, the first annual observation will be of length m while the subsequent ones will be of length one; this will have implications for stationarity assumptions and statistical analysis.[7] The AER does this calculation monthly so that equation (2) would hold except that m would change as one progressed through the year. This would have more complex implications for stationarity as it would bring in a monthly seasonal effect.

For the three-stage model, we are considering m+9 years. This may be a hang-over from the time when 10 year risk free rate rates were used in estimating the allowed rate of return. If this is the case, it may be more consistent to set N = 4 in line with the proposed use of 5 year risk free rates. This raises the point that it is not known what the optimal length for the transition period is and neither is it known what the optimal pattern of change is over that period.

[7] The time series properties determine how the values of the variables will evolve over time, alone and in combination with other variables. Nonstationary time series generally require adjustments such as differencing in order to make them stationary, otherwise spurious results are likely to be obtained from their modelling.

Monthly historical MRP estimates from the DGM

For the purpose of our analysis, data were supplied by the AER, and we supplemented this with data available from public sources. The data covered the period from March 2006 to February 2022. The key elements of this data were monthly estimates of the MRP estimated from the AER's two stage and three stage DGM's using a ten year risk free rate. The AER also provided additional data in the form of descriptive statistics for the inputs to the DGM.

In the Figure 1 below, we present historical time series plots, from March 2006 to February 2021, for the monthly DGM estimates of the MRP. These plots contain both two stage and three stage models and allow for both five year and ten year risk free rates. Several things are immediately evident from these plots. The MRP estimate shows considerable variation period by period. There are sharp and substantial increases which reverse quite quickly. In contrast, the substantial decreases reverse more slowly. In other words, the lowest MRP estimates seem more persistent than the highest MRP estimates.

The plots for both the two stage and three stage models with the alternative risk free rates show a very similar pattern of volatility; they have similar, but not identical, magnitudes for the MRP estimate. The three stage models tend to have the highest MRP estimates and using a five year risk free rate tends to give higher values for the MRP than a ten year risk free rate.

After the rise in the estimated MRP from 2011 to 2012, all the MRP series move to a higher level and are less volatile until 2020. The change in the level of the MRP is largely driven by the substantially lower interest rates that prevailed from 2012 onwards coupled with relatively little change in the DGM estimate of the market rate of return *k* between 2011 and 2012 and also a smaller range of variation in those estimates after 2012, particularly in the period until the end of 2018.

In Figure 1A we provide a plot of alternative estimates of the DGM implied market risk premium (the black line) over the same period as the AER estimates. We use these estimates to illustrate similar patterns in volatility but substantial differences in magnitude that can arise in MRP estimates from the DGM. The alternative estimates are supplied by Fenebris a German consulting group who advise on corporate finance issues with a particular focus on the cost of capital. They provide a comprehensive set of regularly updated estimates for market risk premia internationally using a DGM model. Comparing the Fenebris estimates with the AER estimates, there are close similarities in the pattern of MRPs. This is to be expected since the estimated MRPs both come from DGM models. However, the MRP estimates in Figure 1A from Fenebris are much lower due to a lower estimate of the implied cost of equity. At the end of the period the Fenebris estimate of the MRP is about 3.3% and the AER estimate is about 6% to 6.5% depending on the variant of the AER model.

There are three main differences between the AER method and the Fenebris method of estimating the implied MRP. Fenebris uses more companies, currently 389, but the most important difference from the AER's model is an alternative approach to estimating the long term growth rate. The long term growth rate is used to estimate the terminal value component of DGM models. Fenebris uses the internal growth rate, which is the growth rate that can be sustained without external financing.

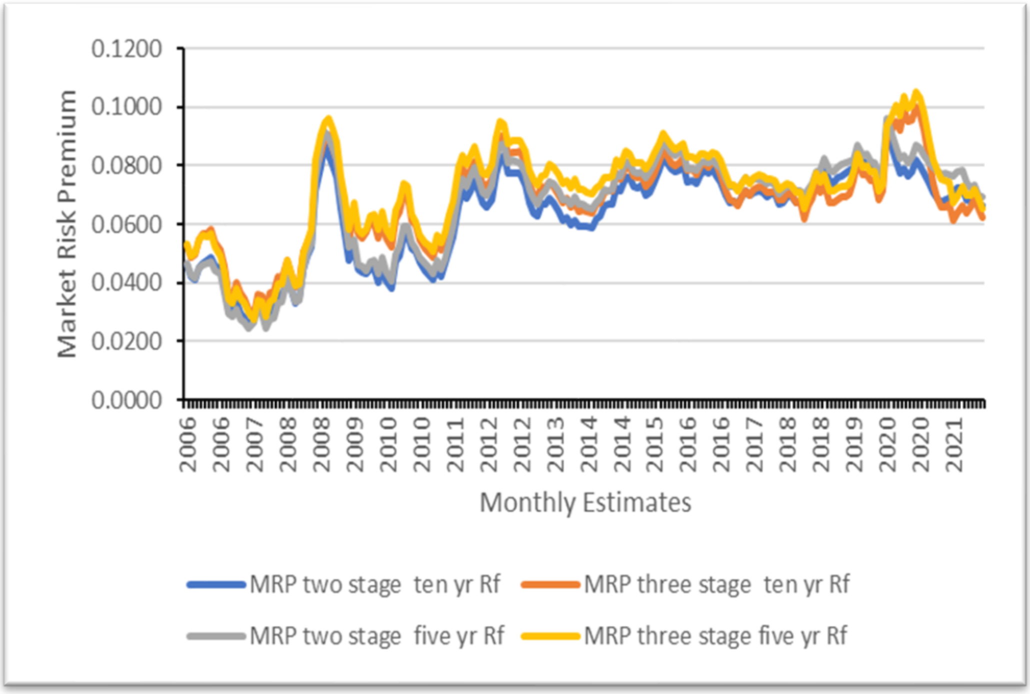

Figure 1: Estimates of the AER implied MRP over time (Source: AER data)

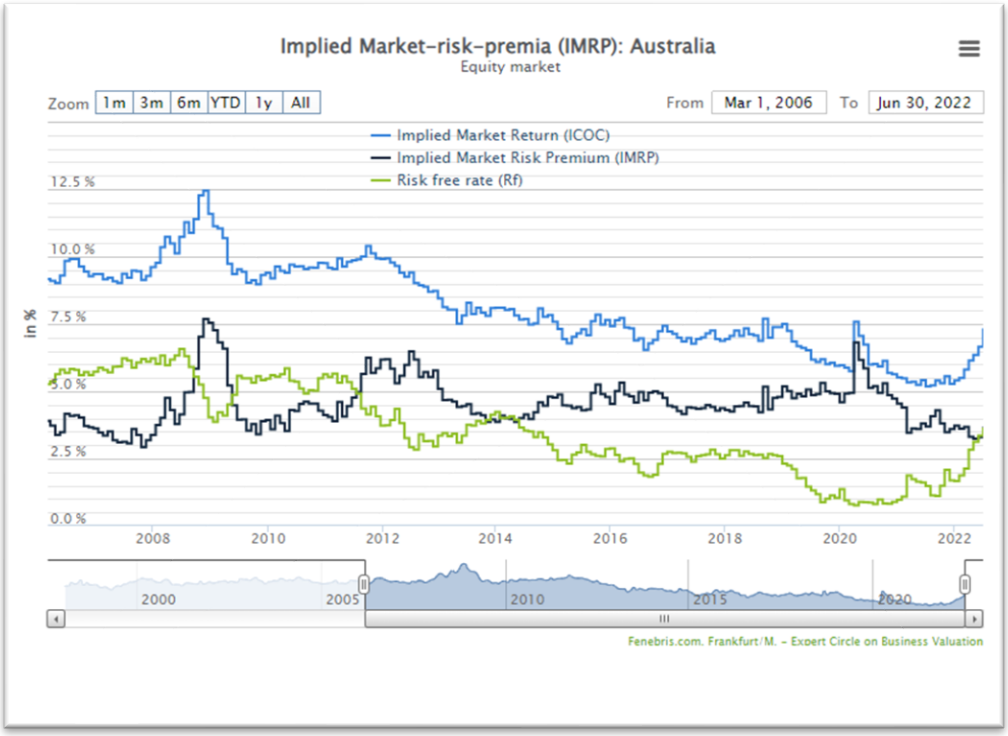

Figure1A: Estimates of the Fenebris DGM implied MRP over time. Source http://www.market-risk-premia.com/au.html.

The DGM model as a simple linear regression

The variation in the time series of estimates of the DGM cost of equity k can be largely explained by variation in the AER's ASX/S&P 200 index.[8] A simple linear regression of k on the market index does a very good job of tracking the AER's estimates of k. Scatter plots for the relation between k and the index are given in Figure 2 (two stage model) and Figure 3 (three stage model). The regression coefficients are given in Table 1. The regressions are of the form:

$$k = \alpha + \beta(Market\ Index) + \epsilon$$

We note that for the regression we have scaled down the index by dividing by 100,000. This only effect of this is to scale up the magnitude of the slope coefficient by 100,000, which facilitates presentation of the results. As Table 1 shows the model has high explanatory power and the estimated coefficients have a high level of statistical significance. The results also show that the three stage model is more sensitive to variation in the index than the two stage model.

	Intercept α	Slope β
Model for: Two stage estimate of k		
Regression Coefficients	0.1438	-0.8230
t statistic	77.2166	-24.3592
Prob Level (t Test)	0.0000	0.0000
R-Squared	0.7575	
Model for: Three stage estimate of k		
Regression Coefficients	0.1677	-1.1799
t statistic	90.0137	-34.8923
Prob Level (t Test)	0.0000	0.0000
R-Squared	0.8650	

Table 1: Regression model for k as a function of the market Index

[8] We call this the AER ASX/S&P 200 Index because the AER uses the average of the daily observations for the month as its measure of the index and also uses the average of daily forecast dividends over the month. Why this is done is an open question.

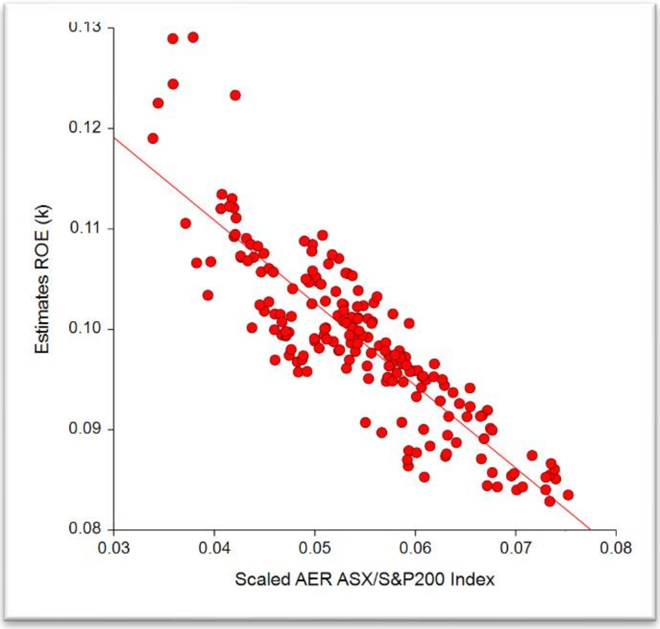

Figure 2: Two stage model *k* v AER ASX/S&P200 Index.

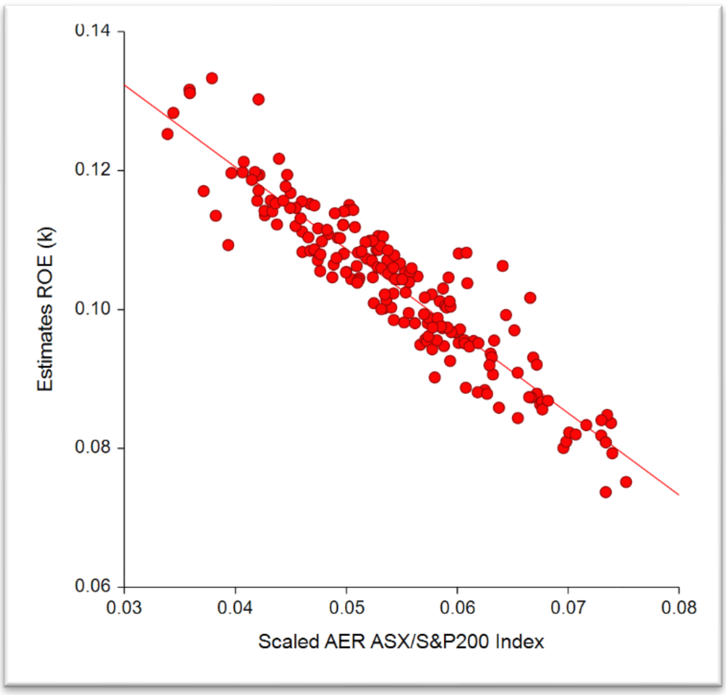

Figure 3: Three stage model *k* v AER ASX/S&P200 Index.

In the interest of simplification, saving effort, and enhancing transparency, the AER could just adopt the regression models in place of the DGM. Clearly, the regression models do a good job of tracking the DGM estimates of the market rate of return and in our opinion will give estimates that are likely to track the true variation in the MRP just as well as the estimates based on the DGM. That is to say not very reliably.

The bottom line of this analysis is that the use of the DGM model results in a strong negative relation between *k* and the level of the market index. This is no surprise to us, and we explain the reason for it below.

Why the DGM estimates are a negative function of the market index.

The problem is that the DGM estimates are loading most of the explanation for change in the level of the market index on discount rate news. Whereas the level of the market index may vary because of cash flow news (e.g., higher expected cash flows increase the market index); or discount rate news, (e.g., lower discount rates increase the market index); or some combination of the two types of news.

The use of forecast dividends is an attempt to capture the cash flow news but is inadequate for that purpose. We have previously explained,[9] in general, the problems that smoothing of dividends by management and the nature of analysts' forecasts create in using these forecasts to form MRP estimates. Particular problems in the current data are the very large role played by the terminal value calculation, which we discuss below, and the three year horizon for explicit forecasts of dividends.

Three years of explicit dividend forecasts is simply not long enough to reliably capture the variation in expected future cash flow. Managers smooth dividends relative to profits and underlying cash flow in an attempt to create a steadily increasing stream of dividends over time. To this end they only gradually increase dividends as profits and cash flow increase and often make no change at all. When bad times come, and profits and cash flow decline, their initial

[9] See, for example, *Report to the AER: Alternative asset pricing models*, G. Partington and S, Satchell, June 2020.

response is to hold the dividend constant and try and weather the storm. Cutting the dividend is seen as a last resort and is only likely to occur if the decline in profits and cash flow is substantial and sustained. When, for example, internal funds are insufficient to finance dividends and investment, the dividends will be commonly financed by borrowing and/or by raising equity and more rarely by cutting investment. Raising equity was historically rare, but post the introduction of the imputation system, the rising dividend payout ratios led to a need to replenish equity which was achieved through dividend reinvestment plans.[10]

This pattern of behaviour has two important effects relevant to the current analysis. First given that managers adjust dividends slowly and often don't change them at all there is little reason for analysts to substantially revise their short term dividend forecasts, a problem that is compounded by the known sluggish revision of analysts' forecasts. Thus, for example, if there is a sharp fall in the market it is unlikely that analysts' short term dividend forecasts will be very substantially revised downwards, and such revisions as there are may well come with a lag to the movement of the market index. The consequence is a higher estimate of k and the MRP when the market falls. Second even if the analysts' dividend forecasts are good forecasts for the next three years, it is likely that the consequences of financing, that is lower future dividends, will be felt beyond the three year forecast. Again, the consequence is a higher estimate of k and the MRP. When the market rises sharply, the foregoing operates in reverse, with an underestimate of k and the MRP. These rise and reversals in the DGM estimates of the MRP are what we see in Figure 1 at times when the market has moved sharply down and then up, for example during the COVID crisis in 2020.

Too explain a little more, smoothing dividends by financing has consequences. It is well understood that financing higher dividends now means a reduction of dividends in the future. That is the value of future dividends goes down, and vice versa when free cash flow to equity is used to repay financing or is reinvested in

[10] This latter means that actual dividends overstate the amount of cash that investors receive as a consequence the dividend distribution.

the firm. In an ideal model such changes in the value of future dividends would be captured by extending the dividend forecasts well beyond three years.[11] In the current model the present value of dividends beyond three years is captured in the terminal value term. This terminal value is unable to reflect variation in dividend growth rates since it is assumed that a steady state has been reached where dividends grow at a constant rate. Unfortunately, the terminal value is the major part of the index valuation, as we discuss below. It depends on the assumed long run growth rate *g,* which we discuss later.

The importance of the terminal value

The explicit dividend forecasts, covering the first three years, are a small fraction of the index valuation. The balance comes from the terminal value of the model, which is given by the final term of the AER's model:

$$\frac{\mathrm{E}(D_N)(1+\mathrm{g})}{(k_c - g)(1+k_c)^{m+N-1/2}}$$

This terminal value is the overwhelming contributor to the total present value of the dividend forecast. For example, in the two stage model, as a percentage of the total value of the index the terminal value observed monthly had a mean of 86.7% and a minimum of 79.2%. Thus, the estimate of *k* and hence the MRP depends on the assumptions that underpin the estimate of terminal value. In other words, the estimate of the MRP substantially depends on the estimate of the long run growth rate *g*. The estimates of the monthly MRP in the Figure 1 used the same growth rate (3.74%) for all monthly MRP calculations. We discuss the potential variation in the growth rate in our sensitivity analysis below.

Descriptive statistics

Descriptive statistics for the output from the AER DGM models and the AER/ASX 200 price index are given in Table 2. These statistics confirm the earlier observations that the three stage models tend to give the highest value for the MRP, as a consequence of estimating a higher value for the return on equity *k*.

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[11] In reality, the problem is obtaining accurate forecasts beyond three years.

The ten year value for the risk free rate is higher than the five year value. This is consistent with a positive slope to the term structure of interest rates being the normal state of affairs. As a consequence, the highest mean estimate of the MRP at 7.14% is obtained using the three stage model and the five year risk free rate. However, the mean estimates of MRP across the models do not vary greatly. The notable feature is the range of the variation in the MRP through time. Across all the MRP estimates the range of estimates is about 7%. It is interesting to observe that the estimates of the return on equity *k* are less volatile than the risk free rates as they have a lower standard deviation, and the estimates of *k* are also less volatile that the estimates of the MRPs.

Variable	Statistic					
	Count	Mean	Standard Deviation	Standard Error	Median	Minimum
Rf 5 yr	192	0.0321	0.0183	0.0013	0.0282	0.0029
Rf 10 yr	192	0.0357	0.0166	0.0012	0.0325	0.0082
K 2 stage	192	0.0990	0.0085	0.0006	0.0988	0.0829
K 3 stage	192	0.1036	0.0114	0.0008	0.1047	0.0737
MRP2/5	192	0.0669	0.0176	0.0013	0.0731	0.0242
MRP3/5	192	0.0714	0.0165	0.0012	0.0740	0.0276
MRP2/10	192	0.0633	0.0157	0.0011	0.0683	0.0255
MRP3/10	192	0.0679	0.0146	0.0011	0.0695	0.0292
AER/ASX 200	192	5438.07	896.015	64.6643	5413.02	3389.66
	Maximum	Range	Kurtosis	Skewness		
Rf 5 yr	0.0669	0.0640	1.9003	0.2672		
Rf 10 yr	0.0659	0.0577	1.7916	0.0919		
K 2 stage	0.1291	0.0462	4.2425	0.6036		
K 3 stage	0.1333	0.0596	2.9678	-0.1541		
MRP2/5	0.0961	0.0718	2.5950	-0.8788		
MRP3/5	0.1053	0.0777	3.2359	-0.7027		
MRP2/10	0.0922	0.0666	2.4337	-0.7435		
MRP3/10	0.1000	0.0708	3.1542	-0.5030		
AER/ASX 200	7522.09	4132.47	2.6470	0.1504		

Key to variables:

- Rf 5 yr = five year risk free rate
- Rf 10 yr = 10 year risk free rate
- K 2 stage = DGM return on equity estimated from the two stage model
- K 3 stage = DGM return on equity estimated from the three stage model
- MRP2/5 = DGM estimate of the MRP from the two stage model with five year risk free rate
- MRP3/5 = DGM estimate of the MRP from the three stage model with five year risk free rate
- MRP2/10 = DGM estimate of the MRP from the two stage model with ten year risk free rate
- MRP3/10 = DGM estimate of the MRP from the three stage model with ten year risk free rate
- AER/ASX 200 Monthly average of the daily ASX/S&P 200 price index used by the AER

Table 2: Descriptive Statistics for variables in the DGM analysis

Correlations, autocorrelations and their implications

Turning to the question as to whether theory suggests that adding the different estimates of MRP (HER and DGM estimates) is sensible. One line of enquiry would be to look at the contemporaneous (correlations) and time-series properties (autocorrelations) of the two estimates. We acknowledge that there may be circumstances where the differences in the alternative estimators of the MRP might be advantageous, but in any case, understanding the differences allows us to consider possible patterns of weights other than equal weighting (0.5, and 0.5) among a number of other issues.

We consider the weighting issue in later sections of the report. Here we present a matrix of contemporaneous correlations, which provide us with insights into the bivariate relations between the risk free rates, estimates of ROE, estimates of the MRP and the AER's measure of market value the AER/ASX200 price index.

	Rf 5yr	Rf10yr	K 2stage	K 3stage	MRP2/5	MRP3/5	MRP2/10	MRP3/10	AER/ASX 200
Rf 5 yr	1.0000	0.9938	0.3126	0.4595	-0.8896	-0.7920	-0.8843	-0.7727	-0.4540
Rf 10 yr		1.0000	0.3629	0.5084	-0.8589	-0.7517	-0.8635	-0.7415	-0.5044
K 2 stage			1.0000	0.8722	0.1558	0.2531	0.1563	0.2666	-0.8703
K 3 stage				1.0000	-0.0584	0.1783	-0.0670	0.2007	-0.9301
MRP2/5					1.0000	0.9454	0.9947	0.9317	0.0536
MRP3/5						1.0000	0.9336	0.9939	-0.1363
MRP2/10							1.0000	0.9303	0.0638
MRP3/10								1.0000	-0.1507
AER/ASX 200									1.0000

Key to variables:

- Rf 5 yr = five year risk free rate
- Rf 10 yr = 10 year risk free rate
- K 2 stage = DGM return on equity estimated from the two stage model
- K 3 stage = DGM return on equity estimated from the three stage model
- MRP2/5 = DGM estimate of the MRP from the two stage model with five year risk free rate
- MRP3/5 = DGM estimate of the MRP from the three stage model with five year risk free rate
- MRP2/10 = DGM estimate of the MRP from the two stage model with ten year risk free rate
- MRP3/10 = DGM estimate of the MRP from the three stage model with ten year risk free rate
- AER/ASX 200 Monthly average of the daily ASX/S&P 200 price index used by the AER

Table 3: Pearson product moment correlation matrix for variables in the DGM analysis.

In Table 3 we present the correlations between the various quantities we use throughout this report. We shall refer to these correlations when needed but some immediate comment will be useful. If we have two variables with different means but very similar stochastic components, we are likely to see a high correlation between the pair. We note that MRP2/5, MRP2/10, MRP3/5, and MRP3/10 fall into this category; they all have pair-wise correlations in excess of 93%. Likewise, Rf 5 yr and Rf 10 yr are highly correlated, reflecting a well-known property of yield curves. It is interesting that K2 and K3, whilst being reasonably highly correlated (87%) are less highly correlated than the corresponding MRP's. This is because both K1 and K2 have low variance compared with Rf 5 yr and Rf 10 yr and that, coupled with their high correlation creates the high MRP correlations, we discuss this in detail below. It is an artifice of the properties of the different interest rates.

One might think that MRP2/5 and K2 should have a high correlation; they do not, it is 15%. This is again a consequence of K2's low variance compared with Rf 5 yr. The same phenomenon occurs with MRP3/5 and K3, MRP3/10 and K3 and MRP2/10 and K2. We formalise this discussion next.

Let $X_t = K2, Y_t = Rf\ 5\ yr$, then $X_t - Y_t = \frac{\text{MRP2}}{5}$.

$$cov(X_t - Y_t, X_t) = Var(X_t) - cov(Y_t, X_t);$$

$$corr(X_t - Y_t, X_t) = \frac{Var(X_t) - cov(Y_t, X_t);}{sd(X_t)sd(X_t - Y_t)}$$

Where: *cov* is covariance, *corr* is correlation and *Var* is variance.

If we make the simplifying assumption that $corr(Y_t, X_t) = 0$ (in our example, it is 31%, but we avoid a lot of algebra by assuming it is 0); then,

$$corr(X_t - Y_t, X_t) = \frac{Var(X_t)}{Var(X_t)\sqrt{1 + \frac{Var(Y_t)}{Var(X_t)}}}$$

$=\frac{1}{\sqrt{1+\frac{Var(Y_t)}{Var(X_t)}}}$; so if $Var(X_t)$ is much smaller than $Var(Y_t)$, the correlation $corr(X_t - Y_t, X_t)$ will be small.

We observe a similar pattern in autocorrelations. Autocorrelations are correlations of a variable with its past values and allow us to understand time-series behaviour of variables. The mathematics behind these outcomes are as follows. Consider a spread between X and Y; suppose they are independent to avoid unnecessary mathematical detail. Then

$$cov(X_t - Y_t, X_s - Y_s) = cov(X_t, X_s) + cov(Y_t, Y_s)$$

$$Var(X_t - Y_t) = Var(X_t) + Var(Y_t)$$

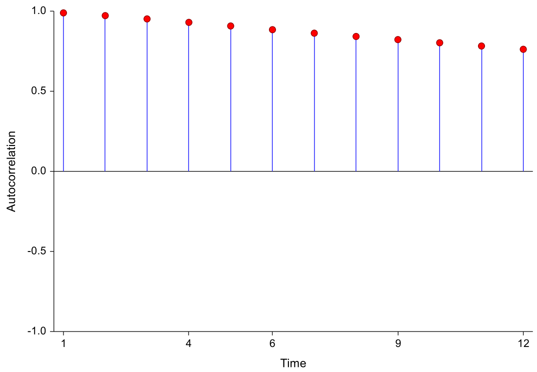
Assuming stationarity, we see that the correlation,

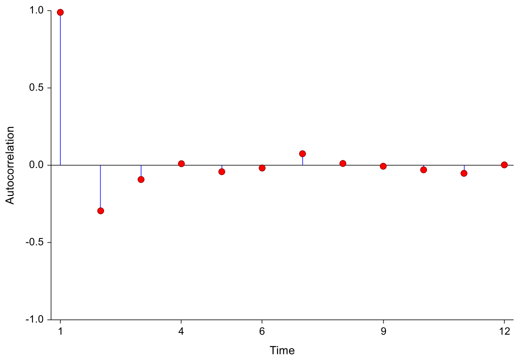
$$corr(X_t - Y_t, X_s - Y_s) = \frac{Var(X_t)corr(X_t, X_s) + Var(Y_t)corr(Y_t, Y_s)}{Var(X_t) + Var(Y_t)} \tag{4}$$

Equation (4) gives a simple explanation as to why different MRP's have different patterns of autocorrelation. If X has a much larger variance than Y, then X-Y will have a correlation pattern like X's. As an example, consider X = some version of the ASX200 and Y = Rf5 or Rf10. If we take just the monthly return for the ASX then its volatility will be much larger than that of five or ten year yields and the resulting autocorrelation will look like that of the ASX, that is low autocorrelation. If we take the ASX to be some average of the last T months this will reduce the variance and eventually the resulting MRP's autocorrelation will look like that of Rf5 or Rf10. Similarly, the variances of K2 and K3 are very small so MRP's based on them will largely have autocorrelation patterns similar to Rf5 or Rf10.

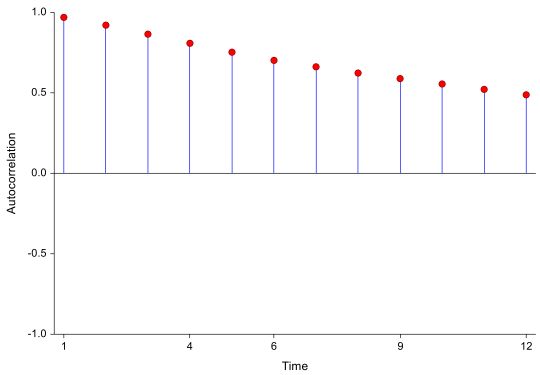
In the interests of not swamping the report with output, we do not present autocorrelation results for all the variables. The results we present are representative, for example, the pattern and magnitudes of autocorrelation for *k*2 are similar for *k3*. To aid interpretation we present the results as autocorrelation plots followed by partial autocorrelation plots. The plots have the magnitude of the autocorrelation on the vertical axis and time on the horizontal axis with lags to 12 months. The partial autocorrelations take out the effect of the autocorrelations at intervening lags out to 12 months. For example, the interpretation of the plots for Rf 5yr is that there is a very high correlation, (almost 1) at lag 1 slowly declining over the next 12 months. The partial autocorrelation plot for Rf 5yr shows that the results are driven by the strong autocorrelation at lag 1, and MRP2/5, *K*2 and ASX 200 all show a very similar pattern. However, the excess returns proxy ASX/AER 200 -Rf 5yr shows very little autocorrelation with a small positive autocorrelation at lag 1, the effect of which dies out straight away.

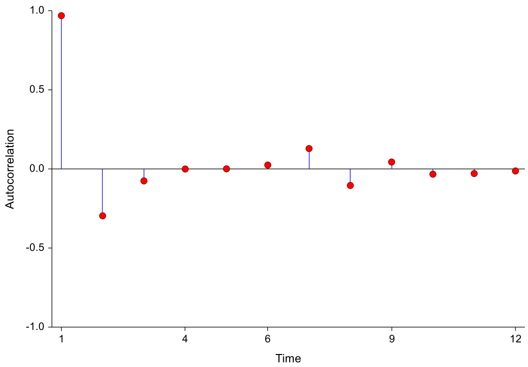
Rf 5yr



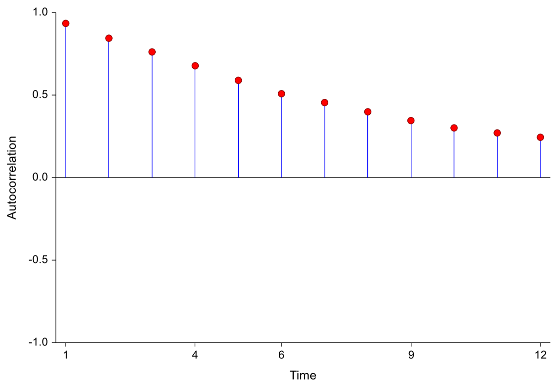


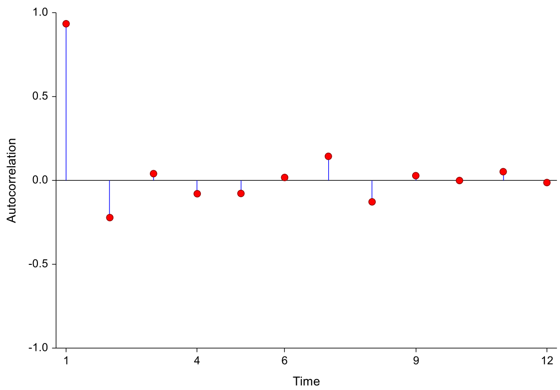
MRP 2/5



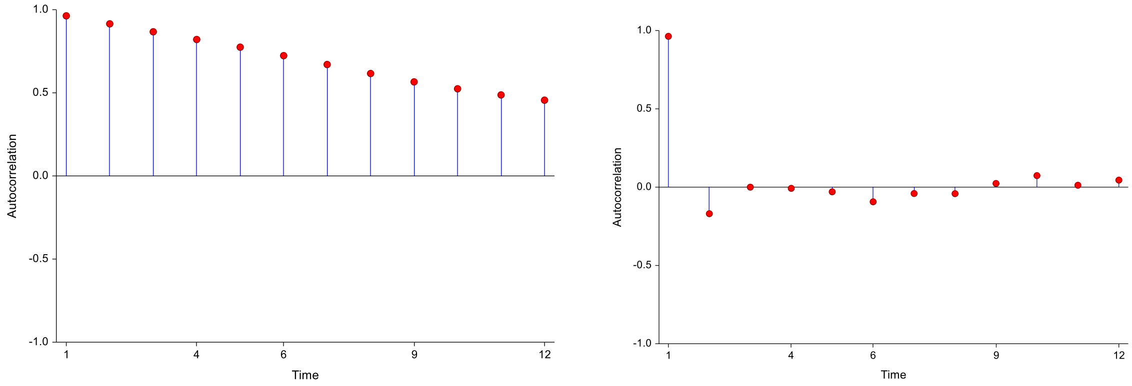


K2

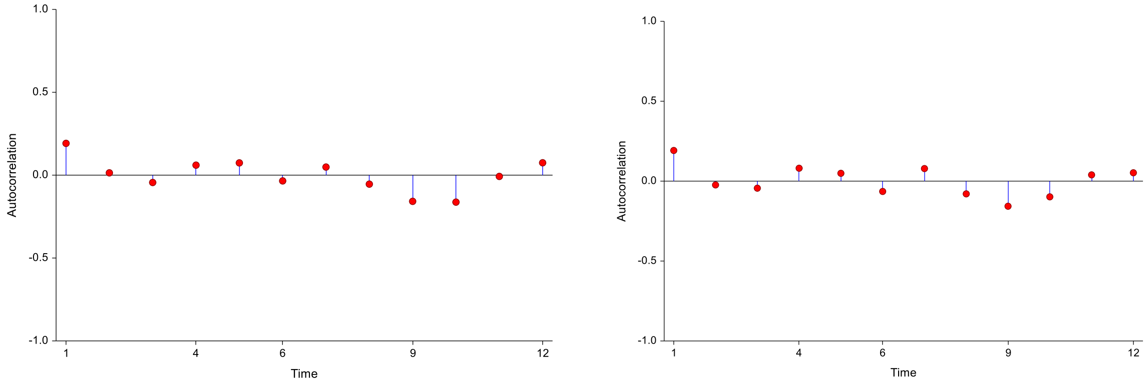




AER/ASX 200



ASX/AER200 -Rf 5yr



Sensitivity to the level of the risk free rate

With regard to the impact of specific variables on the estimated MRP, we first consider the impact of the risk free rate. The sensitivity of the MRP estimate to the level of the risk free rate will depend on changes in the level of the risk free rate and how the estimate the implied cost of capital *k* varies with the risk free rate. The correlation between *k* and Rf is positive, varying between 0.31 and 0.51 across the alternative estimates of *k.* Consequently, there will be some tendency for rises in *k* to be offset by rises in Rf. However, as the correlations are modest the two variables will not move in lockstep and at times may even move in opposite directions.

As discussed earlier, a substantial reduction in the risk free rate post 2011 coupled with a little changed and relatively stable estimate of the implied cost of capital led to a substantial and sustained increase in the estimated MRP. The effects on the mean value of MRPs are shown in Table 4, where the differences range from 1.90% to 2.81%. The evidence of history, therefore, is that the sensitivity of the level of the estimated MRP to the level of the risk free rate is a substantive matter.

	MRP2/5	MRP3/5	MRP2/10	MRP3/10
Mean 2006 to 2011	4.90%	5.72%	4.76%	5.58%
Mean 2011 to 2022	7.71%	7.96%	7.23%	7.48%
Change	2.81%	2.24%	2.47%	1.90%

Table 4: MRP under changed interest rate regimes.

Sensitivity to the term of the risk free rate

With respect to the choice of a five or ten year risk free rate, the impact will depend on the slope of the yield curve. In the usual case of an upward sloping yield curve, the use of the ten year government bond rate as a proxy for the risk free rate will result in a lower MRP relative to the use of a five year government bond.

From1972 to 2022 the mean difference observed in monthly data between the five and ten year bond rates was 0.25% in annualised terms. So, on average the MRP using the 5 year bond rate would have been higher by this amount. On occasion, however, there would have been substantial differences, the maximum by which the ten year bond rate exceeded the five year bond rate was 1.3% and the minimum difference was minus 0.95%.

Over the period of our AER data, as the descriptive statistics in Table 2 show, the mean MRP was higher when the five year government bond rate was used, increasing the estimated MRP by 0.36%. The difference was highly statistically significant (at better than the 1% significance level). In these data, the maximum difference by which the MRP with the five year rate exceeded the MRP with the ten year rate was 0.98% and the minimum was minus 0.34%.

The results are quite similar in both the longer and shorter data series. On average the use of the five year bond rate will give a somewhat higher MRP, but more extreme differences will arise occasionally. The extremes are asymmetric, as reflected in the magnitudes of the maximum and minimum differences.

Sensitivity to dividends and dividend yields

Higher current dividends, other things equal. will result in higher dividend yields. However, changing dividend yields will not directly affect the AER MRP estimate as dividend yields are not part of the AER's model. What matters is the forecast of dividends. We note that an increase in the current dividend will likely lead to an increase in analysts' forecasts of future dividends and vice versa, Increases are more likely than decreases because managers attempt to construct an increasing stream of dividends over time

An increase in the forecast of dividends, other things equal, will increase the estimate of the MRP. We do not have the data on the consensus forecasts, but the AER have provided a sensitivity analysis as in Table 5, assuming a long term growth rate of 3.74% and a risk free rate of 10%. As explained earlier we would expect the three explicit forecasts of dividends to play a lesser role than terminal value in the calculation of the MRP. We would also not expect large changes in dividend forecasts period by period. However, Table 5 gives a difference of between maximum and minimum MRP observations of about 1.25%, which is substantive.

There are two factors contributing to this substantive effect. The first is that the minima are observed for the two month averages and the maxima for 12 month averages. There second is that the difference between the maximum and minimum forecasts of dividends is an increase of 20%. A 20 % increase in dividends across the whole market is a large increase in dividends and we would expect a change of this magnitude in analysts' forecasts to be unusual. If, for example, we take the difference for 12 month averages between the unadjusted analysts forecasts and the analysts forecasts plus 10%, then the differences in the MRP shrink to 0.47% for the two stage MRP and 0.44% for the three stage MRP. Furthermore, even a 10% shift in analysts dividend forecasts month to month would be a very substantial change. The appropriate conclusion to be drawn from Table 5 is that changes in analysts' dividend forecasts are likely to only have a modest effect on the estimated MRP.

	Two stage MRP %	Three stage MRP %
Unadjusted analysts' forecasts		
2 month average to end February-2022	6.44	6.13
6 month average to end February-2022	6.69	6.35
12 month average to end February-2022	6.73	6.38
Analysts' forecast - 10%		
2 month average to end February-2022	5.96	5.68
6 month average to end February-2022	6.21	5.90
12 month average to end February-2022	6.26	5.94
Analysts' forecast + 10%		
2 month average to end February-2022	6.92	6.59
6 month average to end February-2022	7.17	6.80
12 month average to end February-2022	7.20	6.82
Minimum	5.96	5.68
Maximum	7.20	6.82
Difference	1.24*	1.14*

*Note: These differences somewhat overstate the likely sensitivity of the MRP to variation in analysts' dividend forecast

Table 5: Changes in dividend forecasts and the MRP (Source AER)

We expect a critical sensitivity in the calculation of the MRP to come from the terminal value. The third dividend forecast feeds into this terminal value, and a critical variable here is the assumed long term growth rate in dividends, which we examine next.

Sensitivity to the long run growth rate g

The AER bases its estimate of the long run growth rate on the real growth rate in GDP less an allowance for future contributions of equity capital less buybacks and then adjusts this value to a long run nominal growth. The inflation adjustment is made via the Fisher equation. The AER's adjustment for future contributions of equity capital is to deduct 1% from the forecast of real growth in GDP. Thus, the AER's estimate of the long run growth rate is given by:

$$g = (1+ \text{forecast real GDP} - 1\%)(1+\text{expected inflation}) - 1$$

This approach to estimating the long run growth rate is a reasonably well-accepted method, but it is not the only method. The method has led to the following estimates by the AER:

Notes	Forecast Real GDP	Expected Inflation at midpoint of RBA inflation target range	Long run Growth Rate *g*
AER 2013 and 2018 determinations.	3%	2.5%	4.6%
GDP growth based on Treasury Intergenerational Report 2021	2.6%	2.5%	4.14%
Based on 2021Consensus Economics Forecast of Real GDP growth and Inflation	Not disclosed	Not disclosed	4.01
Based on Recent Consensus Economics Forecast of Real GDP growth and Inflation	Not disclosed	Not disclosed	3.74%

Table 6: AER Long run dividend growth forecasts

The AER also reports an estimate of the long run growth rate of 6.02% based on their analysis of the ENA calibrated DGM. Thus, even in this limited set of estimates there is substantive variation with a range of 2.28% in the estimates and also a shift in the Consensus Economics forecast of 0.27% over one year.

The mean value for *g* estimated from Consensus Economics forecasts over the period covered by our study is 5.78%, with a range of 3.49%. In Table 7 we report the result of computing *g* using the minimum values of Consensus Economics forecasts for inflation and real GDP. We then repeat the computation using the maximum values for those variables.[12] The value of *g* runs from 3.7% to a 7.7%.

It might be argued that such extremes are unlikely to be reached. However, the current AER estimate of 3.74% is very close to the lower bound of 3.7%. Furthermore, it is quite reasonable to anticipate low inflation when the economy is depressed and growth expectations are down and vice versa.

	Inflation	Real GDP	Long run Growth Rate *g*
Minimum forecast value observed	2.32%	2.39%	3.7%
Maximum forecast value observed	4.90%	3.70%	7.7%

Table 7: Possible range for *g* using extremes in Consensus Economics Forecasts.

A rate of 7.7% seems very high relative to the experience of recent decades, but it will not seem so high if currently rising inflation is not brought under control. One of the authors in predicting falling stock prices just before the 1987 stock market crash did so because he anticipated difficulties in maintaining an expected growth rate in dividends of around 20%. Before the 1987 crash inflation had been running at a little above 9%. A rate that is very high compared to recent decades. However, it not at the top of the range of historic rates of inflation. The peak inflation rate in 1975 of 17.7% was nearly double the rate in 1987. Combining 1975 inflation with a Consensus Economics minimum 2.32% growth rate in real GDP gives an estimate of the long run growth in dividends of 19.25%, with the maximum forecast of 4.9% real GDP growth the dividend growth rate estimate is 22.29%. Of course, it is likely that in 1975 the expected long run level of inflation was substantially less than 17.7%. Thus, the foregoing

[12] The maximum and minimum values are drawn from descriptive statistics for the data.

calculations give a range that is so extreme as to be very unlikely, but not impossible.

We could go on introducing other estimates of g, using other methods of estimation, but we think the point is made. Even restricting the estimate of g to the AER's method, the range of estimates of g can be substantial. Furthermore, g may shift substantively over a year or so. Indeed, with respect to the latter, if there only trivial shifts over relatively short time intervals there would be little need for the AER to update its estimates of g over the regulatory cycle.

Clearly given the importance of the terminal value in the valuation of the index, the value for the rate of growth will have a substantive impact on the estimate of k and hence on the MRP. The lessons of historic variation in inflation tell us that the variation in g over time could be very large.

It is important for us to remind the reader that in the estimates of g above, the allowance for future contributions of equity capital was fixed at 1% of real GDP growth. As we later discuss a further source of variation in g lies in alternatives to the 1% estimate.

The results of changing g on the magnitude of the MRP estimate are illustrated by the results in Table 8. The table reports estimate of the MRP for the two stage DGM. The results are obtained by first observing values of k in the data closest to the mean, and the actual maximum and minimum of the estimates for k using the growth rate of 3.74%. These values for k are then recomputed after changing g from 3.74% to 4.6% and then to 7.7%. The change in k gives the change that will result in the MRP assuming the same risk free rate prevails for both values of g. The results in Table 8, show that for the two stage model k changes by approximately the same magnitude as the change in g. For the three stage model we would expect a larger effect as the terminal value is expected to be a larger component of value in that model.

Change g by 0.86% from 3.74% to 4.6%			
	Original value k	Revised value k	Difference*
Closest to mean	9.88%	10.68%	0.80%
Maximum	12.91%	13.72%	0.81%
Minimum	8.28%	9.11%	0.83%
Change g by 3.96% from 3.74% to 7.70%			
Closest to mean	9.88%	13.59%	3.71%
Maximum	12.91%	16.65%	3.74%
Minimum	8.28%	12.08%	3.80%

Note: *The difference in k is also the difference in the MRP estimate for a given risk free rate.

Table 8: Illustration of the effect of changing the long term growth rate.

Accuracy of GDP forecasts

Given the importance of g it is relevant to ask how accurate the estimate is likely to be. The accuracy of GDP forecasts is illustrated by Figure 4, which shows RBA forecasts for growth in GDP with a confidence interval. We use GDP because is expected to be closely related to the estimate of g. By 2024 the mean is about 2% and 90% confidence interval for this estimate varies from a small negative quantity to slightly above 4%. Clearly this is not a precisely estimated quantity.

A comparison of GDP forecasts against actual outcomes for many forecasts is presented in Figure 5, which is a graph from The Economist. The figure plots errors in analysts' forecasts of GDP across different countries against the time until the actual GDP is observed. Figure 5 clearly shows the forecasts are rather poor until only a few months remain before the actual GDP is observed. It is also evident that the analysts' forecasts have an upward bias, particularly in the cases where actual GDP fell (the red lines). The average error was an overestimate of 0.6% in years when GDP grew and an overestimate of 1.8% in years when GDP fell. Overall, however, the analysts' forecasts had a smaller average error than a naïve forecast of no change in GDP, where the errors were 1.3% and 3.1% respectively. Of course, this evidence relates to forecasts of GDP in the short run. We might hope that long run forecasts of GDP and g are more accurate, but we are not aware of any studies to show this.

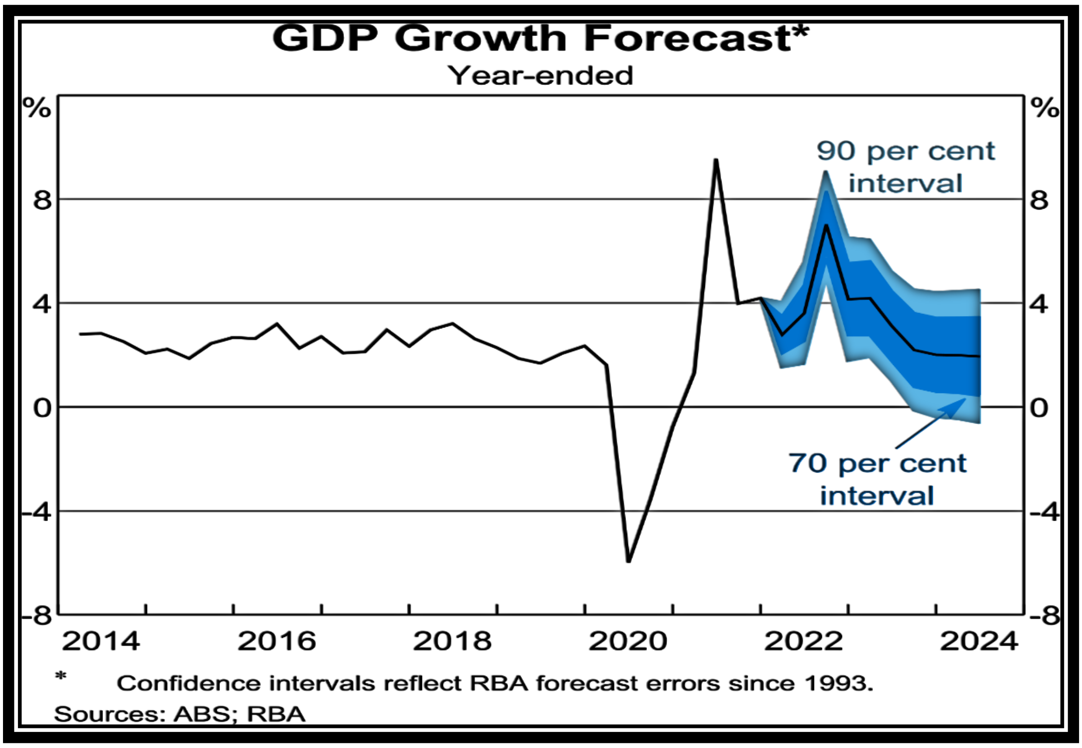


Figure 4: RBA Growth Forecasts from "*Statement on Monetary Policy May 2022*

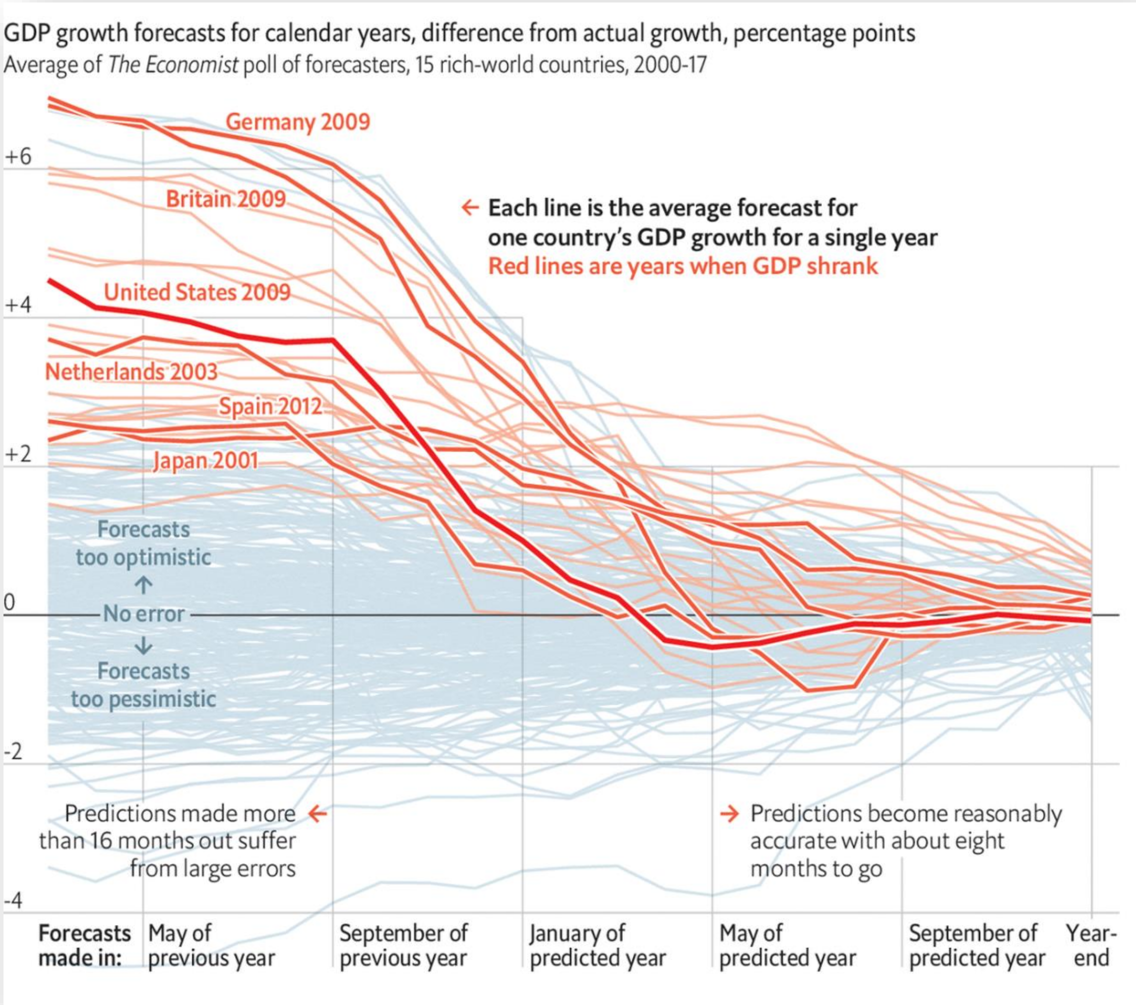
We note that the real test in relation to estimates of the MRP is whether the analysts' forecasts mirror the expectations in the market. We are not aware of studies of this question and such studies would be difficult to undertakes since the expectations are unobservable. We are aware of a strand of literature which questions the informativeness of analysts' forecast announcements. For example, suggesting that:[13]

> *The events reveal a sequential relationship between events and news and forecast revisions indicative of analyst piggybacking, not prophecy. These new findings about the most sought-after analysts reports broaden significantly the evidence indicating that price reactions to analysts' reports reveal little new information.*

The consensus forecasts of dividends will be largely gathered from sell side analysts. So, the estimate is not from a representative sample of all analysts

[13] See p.2550, Altinkilic O., Balashov V. and Hansen R., Are Analysts' Forecasts Informative to the General Public? *Management Science*, 2013, 59:11, 2550-2565.

working in financial markets. It is also the cases that sell side analysts do not always update their expectations in a timely fashion. Consequently, it is no surprise to find reference to whisper numbers, which are analysts' forecasts that have not been published and so do not form part of the consensus forecast.



Source: The worst except for all the others, *The Economist*, December 15, 2015

Figure 5: Accuracy of forecasts of GDP

Finally, we remind readers that the versions of DGM's discussed are models of dividend payments that may have no correspondence in reality but rather are convenient fictions to work with. The assumption that we converge to a steady state of dividend payment growth which then lasts forever can best be described as heroic; its merit lies not in its accuracy but in its parsimony. It allows us to reduce the number of unknown terms we need to consider.

4. Evaluating AER choices - two stage and three stage models and the 1% reduction from GDP growth.

Two stage v three stage models

Since we do not have access to the dividend forecasts our analysis of the effects of the choice between two and three stage models is largely analytical. There are certain things that can be said without recourse to data. We shall first discuss the AER's choice of the N = 9 (three stage model) model over the N = 2 (two stage) model. Whether we use formulae (1), (2), or (3), the N = 9 model will need 10 forecasts of dividends whilst the N = 2 model requires three forecasts of dividends. We know from the earnings literature that it is difficult to forecast earnings more than two periods ahead so that there is very likely that using forecasts nine years past the current year will introduce spurious noise relative to two years out. The modern academic literature tends to assume that dividends follow some stochastic process, but it is not clear that such an assumption is appropriate in this context. The method discussed in the AER's explanatory document is described as (page 143)

> *A 3-stage DGM, like a 2-stage DGM, has a final stage in which the growth of expected dividends is assumed to be equal to the long-term dividend growth rate. It also has an initial stage in which expected dividends are assumed to be determined by estimates of analysts forecasts. However, a 3-stage DGM also has an intermediate stage in which the growth rate of dividends is assumed to transition between the short-term growth rate and the long-term growth rate. This transition between the short-run and long run growth rate is assumed to take place in a linear fashion until the 10th year (the year in which the dividend growth reverts to its long-term growth rate).*

This means that analyst's consensus forecasts are used for the current and next two years, but in the 3-stage model dividend forecasts are generated by linear interpolation between the growth rate associated with the initial growth rate and the long term growth rate. This would not involve any further estimates than the N = 2 (two-stage) model. However, there is no reason to believe that actual dividends would either grow in this way, or over this time period. The essential difference between the two stage and three stage models lies in the terminal values of the models.

The AER two stage model with δ adjustment is given by:

$$P_c = \frac{m\mathrm{E}(D_c)}{(1+k_c)^{m/2}}\delta + \sum_{t=1}^{2}\frac{\mathrm{E}(D_t)}{(1+k_c)^{m+t-1/2}} + \left(\frac{E(D_3)(1+g_1)}{k_c - g_2}\right)\frac{1}{(1+k_c)^{m+3-1/2}}$$

where the last term represents the terminal value.

The type of linear transition of growth rates in the three stage model can be easily modelled by the H model. The AER's N = 9 model can be rewritten as:

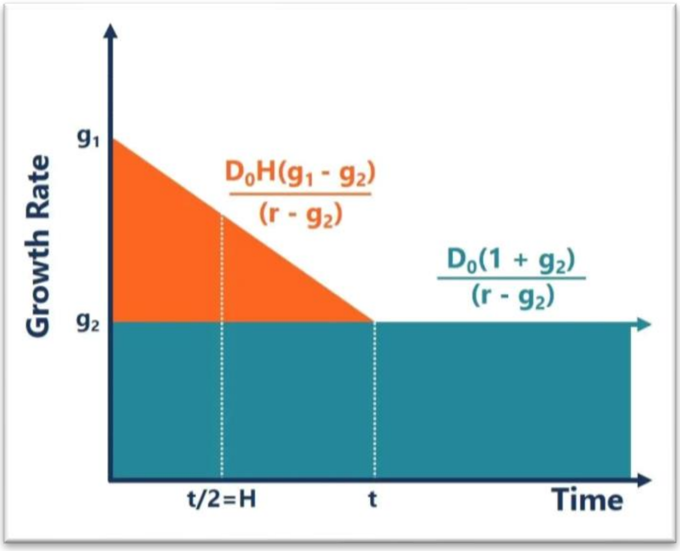
$$P_c = \frac{m\mathrm{E}(D_c)}{(1+k_c)^{m/2}}\delta + \sum_{t=1}^{2}\frac{\mathrm{E}(D_t)}{(1+k_c)^{m+t-1/2}} +$$

$$\left(\frac{\mathrm{E}(D_3)(1+g_2)}{k_c - g_2} + \frac{\mathrm{E}(D_3)H(g_1 - g_2)}{k_c - g_2}\right)\frac{1}{(1+k_c)^{m+3-1/2}}$$

Where:

H is the half-life of the growth period,
g_1 is the initial growth rate in dividends (the growth rate over the first three years),
g_2 is the long run (terminal) growth rate.

The last term in this equation is the H model valuation of terminal value discounted back to time zero. The behaviour of the terminal value can be seen in a nice graphic for the H model produced by the Corporate Finance Institute, which we reproduce below (Figure 6). D_o in this graphic is the equivalent of E(D_3) and the total area shown is equivalent to the terminal value.



Source: Corporate Finance Institute

Figure 6: The H model representation of terminal value in the three stage model.

What this graphic clearly shows is that a substantial part the terminal value (the green area) is given by E(D_3) grown forward for one period at the long term growth rate and valued as though it continued growing at that rate out to infinity (as in the two stage model). Also there is an increment in value (the red area) depending on the half life of the transition period. Note that consistent with incurable optimisim, growth is assumed to be declining to the long term rate. The result, as is clear from the red area in the figure, is that the longer the half life and the bigger the difference in growth rates the bigger the effect of using the three stage relative to the two stage model.

It is possible to carry out a direct analysis of the NPV's of the two methods if we set their costs of capital equal to a common value, k.The difference in present value between the three stage and two stage models is then given by:

$$\left(\frac{\mathrm{E}(D_3)(1+g_2)}{k-g_2}+\frac{\mathrm{E}(D_3)H(g_1-g_2)}{k-g_2}\right)\frac{1}{(1+k)^{m+3-1/2}}$$
$$-\left(\frac{E(D_3)(1+g_1)}{k-g_2}\right)\frac{1}{(1+k)^{m+3-1/2}}$$

$$=\frac{E(D_3)}{(k-g_2)}\frac{1}{(1+k)^{m+3-1/2}}\big((1+g_2)+H(g_1-g_2)-(1+g_1)\big)$$

$$= \frac{E(D_3)}{(k - g_2)} \frac{1}{(1+k)^{m+3-1/2}} \left((H-1)(g_1 - g_2)\right)$$

(6)

In the diagram above $g_1 > g_2$ and$k > g_2$ by the assumptions of the DGM so that the difference in present value between the three stage and two stage models is determined by H in this situation.If H > 1, it is positive; if H < 1, it is negative.If $g_1 < g_2$, the situation is reversed.

From equation 6 we can see that the difference in present value between the three stage and two stage models in terms of g_2 can be summarised by

$$\frac{E(D_3)(H-1)}{(1+k)^{m+3-1/2}} \left(\frac{(g_1 - g_2)}{(k - g_2)}\right)$$

The term $\left(\frac{(g_1 - g_2)}{(k - g_2)}\right)$ is an increasing function in g_2 if g_1 > k and a decreasing function if g_1 < k .We know that $k > g_2$ by the assumptions of the DGM so that if g_2 >g_1 and H > 1, the two stage model has a higher present value than the three stage model and the difference is decreasing in g_2. if g_2 < g_1 and H > 1, the two stage model has a lower present value than the three stage model. These results on PV will be reversed if H < 1.

In the current case H = 5, the estimates of *k* lie in the range of about 8% to 13% and we expect g_1 to be generally less than these values, also we expect large differences between g_1 and g_2 to be unusual. On this basis, our expectation is that the difference in estimates of the MRP between the two stage and three stage models will usually not be large. On the basis of the incurable optimism bias, we expect the difference to be typically positive. This is what we see in the data. The three stage models give an MRP about 0.45% higher.

The regression results in Section 3 show that the estimates of *k2* from the three stage model are more sensitive to the market index and so we expect them to be more volatile.This shows up in a higher standard deviation of *k2* relative to *k1*. However, this does not translate to a higher standard deviation for estimates of the MRP from the three stage models. The standard deviations are little different between two stage and three stage models, although slightly smaller for the three stage models. We conclude that using the three stage model will affect the magnitude of the MRP estimate, it will typically be a litle higher, but the choice between two and three three stage models is likely to have relatively little effect on the variation of the DGM estimates of the MRP.

The measurement of dividends and the1% allowance for issuing new equity.

We begin by quoting from *Report to the AER: Alternative asset pricing models*, G. Partington and S. Satchell, June 2020, p.53:

> *The fundamental valuation/implied cost of capital model for equity is given by:*
>
> $$E_0 = \sum_{t=1}^{\infty} \frac{E[FCE_t]}{(1+r_E)^t}$$
>
> *Where E_0 is the total value of the firm's equity at time 0, $E[FCE_t]$ is the expected total free cash flow to equity at time t, where expectations are taken at time 0. The cash flow to equity is the cash available for distribution to shareholders and is computed net of any contributions of equity capital to be made at time t, r_E is the required rate of return on equity. As with asset pricing models we have the problem of working with expected values.*
>
> *The relation between the free cash flow model and the dividend valuation model is given by:*
>
> $$E_0 = \sum_{t=1}^{\infty} \frac{E[FCE_t]}{(1+r_E)^t} = \sum_{t=1}^{\infty} \frac{E[DIV_t + EW_t - EC_t]}{(1+r_E)^t}$$
>
> *Where the numerator on the right hand side is the expectation of the total value of the dividend at time t, DIV_t, plus the total equity capital withdrawn from the firm at time t, EW_t, less the total equity capital contributed to the firm at time t, EC_t.*

We will call the cash flow in the numerator on the right hand side of the equation, the net dividend. Clearly using the dividend alone as numerator would not capture all of the net cash flows to equity and hence introduce error into the estimate of the implied cost of equity. Notable omissions would be the cash outflow arising from share buybacks and the cash inflow arising from dividend reinvestment plans, DRPs. Evidence on these cash flows is given in: The rise in dividend payments, M. Bergmann, *RBA Bulletin*, March quarter 2016. In Figure 8 we reproduce a graph from that paper which displays the net cash flow arising from dividends, buybacks and dividend reinvestment plans. What this shows is that over the period for which data were available buybacks and DRPs roughly offset each other, but there was variation in the impact on the net figure year by year.

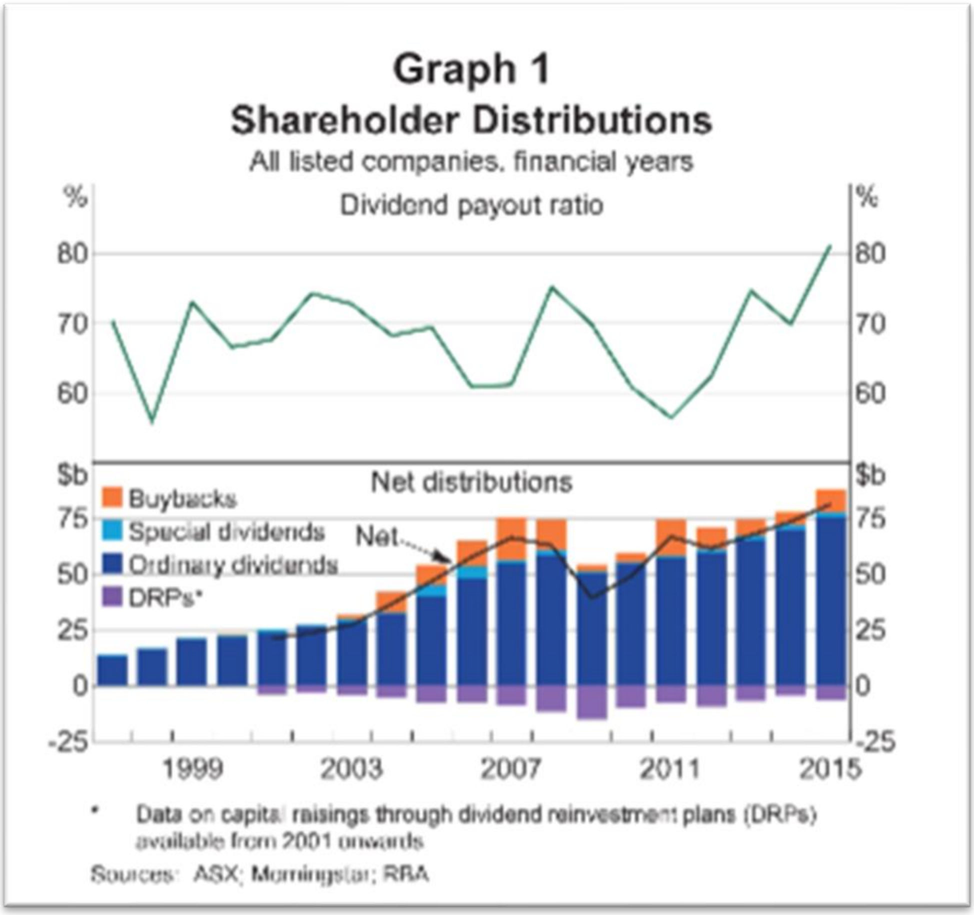


Figure 8: Dividends net of share buybacks and dividend reinvestment plans.

It would be desirable to have on going monitoring of the time series presented in Figure 8. Also desirable would be the item missing from the "net dividends" in Figure 8, that is data on equity raising other than DRPs. *Capital with Confidence: A launch pad to accelerate your growth*, ASX presentation 2022, suggests that this missing item is substantial. Equity Capital raised from placements, rights issues and accelerated issues, and share purchase plans, but excluding DRPs, was reported to be US$34 billion in 2021. This would be a very substantial reduction in the net cash flow to equity for 2021.

The foregoing raises questions about the adequacy of the 1% deduction for future capital contributions net of buybacks that the AER uses in computing the long term dividend growth rate. We note that this estimate is not very solidly pinned down. Using data for the USA, P. Bernstein and R Arnott in Earnings Growth: The Two Percent Dilution, *Financial Analysts Journal*, 2003 Sept/October, suggest a 2% adjustment. M. Lally in *The dividend growth model*, 2013 argues that this is too high. In his illustrative calculations using the DGM he uses adjustments for equity issues of 0.5%, 1% and 1.5% in his analysis. So, 1% is simply the mid-point of this range. The Fenebris estimates neatly sidestep the problem of adjustment for equity issues since they use the internal growth rate, which assumes there is no external financing. This will tend to downward bias their MRP estimate as it excludes not only future equity raisings but also debt issues. However, it does show the substantial difference in the MRP that can arise from alternatives to the 1% adjustment. More research with Australian data is required in order to investigate the appropriate magnitude of this adjustment.

5. Stability analysis under AER Option 3b

AER Option 3b is to use an equally weighted average of the historic equity return (HER) and an estimate from the DGM, with periodic updating over the life of the rate of return instrument.

The desirability and cost of stability

Stability is virtuous if we can come up with numbers that have been stripped of noise so that remaining variation reflects the variation in the true process we wish to measure. In this case, the true variation in the market risk premium. But stability as a goal in itself, without thought concerning the structure of the problem, simply leads to spurious over-smoothing.

The criterion adopted for setting the allowed rate of return is to set that rate so as to make network investment zero NPV. Given variation over time in the MRP and hence in the equilibrium rate of return, then smoothing out that variation is costly, since it moves the allowed rate of return away from a zero NPV outcome. Thus, there is a trade-off between an efficient outcome on the one hand and stable prices on the other.

CRG surveys suggest that consumers value price stability.[14] Stability is another way of saying lower risk. Lower risk means a lower discount rate, which increases the present value of future payment liabilities to consumers and correspondingly increases the present value of payment receipts to the networks. Thus, price stability involves a wealth transfer from consumers to the networks. Most consumers are probably not aware of the wealth transfer, but it is there nonetheless.

The consumer preference for price stability is likely to be because of greater ease in budgeting for power costs and also avoiding the difficulties of rebalancing household expenditure in response to the shock of rising prices. This latter is particularly important to consumers on low fixed incomes. From the point of view of the consumer, we could envisage a utility approach, such as mean variance, where the reduction in expected wealth is compensated by a reduction in the variance of future wealth. Both these reductions arising as a consequence of a stability policy.

Stability and the inverse relation between DGM MRP estimates and Rf

Table 3 shows that there are strong negative correlations between the risk free rates and the estimated MRPs. Consequently, as we explain below, combining DGM estimates of the MRP with the historic excess returns (HER) will tend to smooth out variation in the allowed rate of return on equity

Use of the HER estimate of the MRP alone has the result that changes in the MRP happen infrequently if at all. Thus, for a given beta, changes in the return on equity are driven by changes in Rf. If Rf increases the return on equity

[14] We seem to recall that price stability is also favoured by retailers.

increases and vice versa. In contrast, the DGM estimate of the MRP will tend to be lower when interest rates are higher and vice versa. Thus, combining the DGM estimate of the MRP and the HER will tend to moderate the variation in the allowed rate of return on equity, which has historically been driven by shifts in the risk free rate.

Which model is the best "stabiliser"

We comment on whether the five year risk free rate versus the ten year risk free rate makes any difference to stability, as well as the choice of two stage or three stage models. To do this we consider the covariances between the HER estimates and the various alternative DGM estimates. Unfortunately, we only have 16 HER estimates in the observation period, which makes covariance estimation troublesome as they are annual rather than monthly, estimates. We can, however, proxy matters by instead using monthly excess returns based on the AER/ASX 200 price index. We present the results below. It seems that the interest rate is not material for stability but the choice of K2 or K3 is. Recall that model 3b can be written as MRP = 0.5 HER + 0.5 DGM, where we vary the DGM models then, assuming that variances for the different DGM models are approximately the same, the best "stabilizer" will be the one with the lowest correlation with excess returns. For excess returns using the five year risk free rate the lowest correlation is MRP2/10 closely followed by MRP3/5. For excess returns using the ten year risk free rate the lowest correlation is MRP2/10 followed by MRP3/10. It appears that choosing the two stage model is more stabilising, in a statistical sense, than using the three stage model.

Stability and the term of the risk free rate

As noted above, the choice of a five year or a ten year risk free rate, is likely to have little effect on the stability of the rate of return. This is because the MRPs estimated from the DGMs with five and ten year risk free rates follow each other closely. For both the two stage and three stage models, the correlation between the MRPs using five year and ten year risk free rates is 0.99. The close relation is clearly illustrated in the scatter plot below (Figure 9) which gives the relation between the three stage MRP estimated with the ten year risk free rate and the three stage MRP estimated with the five year risk free rate. Our conclusion is that the choice of risk free rate will affect the magnitude of the estimated MRP, but the stability of the estimate under Option 3b is likely to be little affected by this choice.

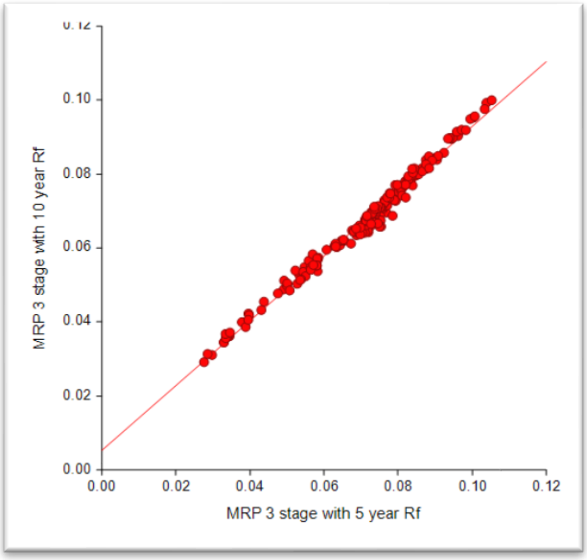


Figure 9: Relation of three stage MRPs with different risk free rates

Stability and variation in the DGM estimates

A question posed by the CRG is whether variation in the inputs to the DGM might lead to less stability under the AER's Option 3b? In order to investigate this question, we compute the return on equity under the AER's Option 1 and Option 3b for the full period of our data (April 2006 to March 2022). We compute the return on equity under Option 1 for a beta of 0.6, assuming an HER for the MRP of 6.5%, and adding the 10 year risk free rate.[15] We compute the rate of return under Option 3b in the same way, except that the MRP is an equally weighted average of 6.5% and the monthly value of the MRP estimate from the three stage DGM[16] with a ten year risk free rate.[17]

[15] Since the HER is a constant in our analysis and the question of interest is the variability of the estimates, the specific value chosen for HER is not particularly important. Different values of HER would change the mean value of the return on equity, but not the variance.

[16] Had we averaged the monthly values this would smooth the variability in the DGM estimates. Using the raw monthly values therefore gives us more variability in the estimate of the MRP and thus gives us a conservative test of whether Option 3b is likely to lead to a more stable allowed return on equity.

[17] Given the high correlation between the risk free rates and the high correlations between the alternative measurements of the MRP from the DGM models, qualitatively similar results are to be expected with alternative choices for either the risk fee rate or the DGM MRP model.

The results are given in a boxplot (Figure 10) and as descriptive statistics Table 8. The boxplot shows that Option 3b has less variability over the period. The descriptive statistics in Table 8 focus on measures of dispersion, that is standard deviation, range and mean absolute deviation. All of these are smaller for Option 3b. The difference in standard deviations is statistically significant (significant at better than the 1% level). The mean is higher under Option 3b, but we note that the difference between Option 1 and Option 3b shrinks as the HER gets bigger, at an HER of 6.8% the difference in means for the current calculations would disappear.

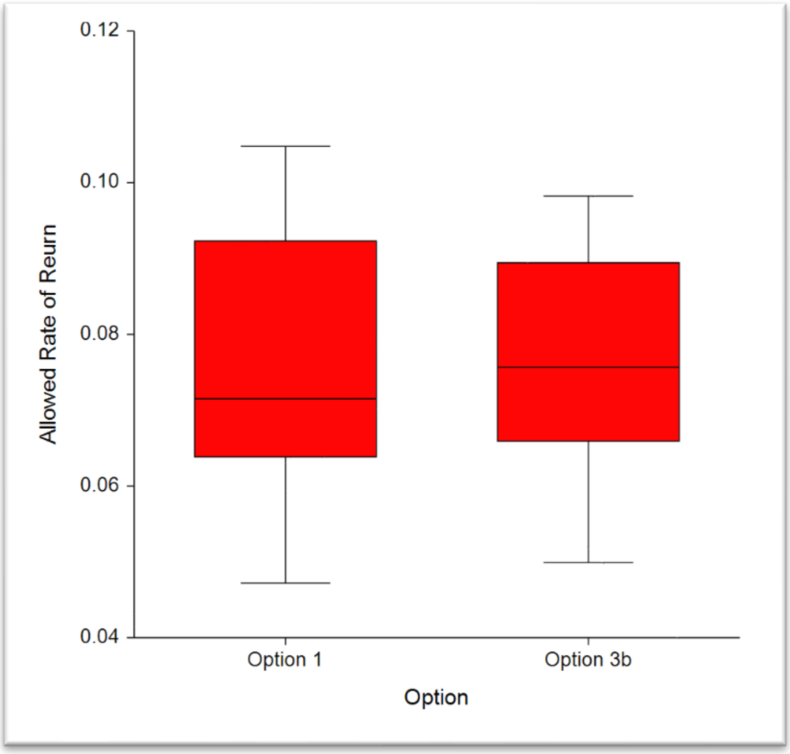


Figure 10: Boxplots for return on equity under Option 1 and Option 3b.

	Option 1	Option 3b
Mean	0.0747	0.0756
Standard Deviation	0.0166	0.0137
Minimum	0.0472	0.0499
Maximum	0.1049	0.0983
Range	0.0577	0.0484
Mean Absolute Deviation	0.0144	0.0119

Table 8: Distribution statistics for the return to equity under Option 1 and Option 3b.

We conclude that it is to be expected that Option 3b will result in allowed returns on equity that are more stable over time than using the HER estimate alone. However, the differences are not great. Furthermore, the result is conditional on the value of g, as a single value of g was used by the AER in computing their MRP estimates. The stability advantage to the weighted MRP might not persist if changes in g were frequent.

Stability and Weighting of HER and the DGM estimates

The analysis has proceeded on the maintained assumption the two components, HER and DGM should be equally weighted. We explore this assumption. If stability was to mean low aggregate variance then we would choose a non-negative weight, w, to minimise

$$Var(wHER + (1 - w)DGM). \tag{5}$$

If $Var(DGM)$ is much smaller than $Var(HER)$, this would suggest that we put a higher weight on the DGM term. Conversely, if $Var(DGM)$ is much larger than $Var(HER)$, this would suggest that we put a lower weight on the DGM term. The point here is that if we allow the length of history to increase we would in principle expect $Var(HER)$ to tend to 0 (in practise to get very small), so that by using a long/increasing history for calculation of HER should also act as a stabilising strategy when coupled with an analysis based on (5).[18] Of course in

[18] We note that unfortunately a sufficiently long history for a very low variance in HER has proved elusive.

choosing optimal weights we would also need to consider the correlation between the variables.

Rationale for option 3b

A natural question to ask is why the AER is considering option 3b? The desire to allow for a changing market risk premium is understandable. This is given by a conditional estimate of the MRP. If you had confidence in your conditional estimate, then presumably that is what you should use in preference to the unconditional estimate of the long run mean (HER). We think this would be a very bad idea because we have little confidence in the conditional estimate. It seems the AER shares our lack of confidence to some degree since they do not propose using the DGM MRP estimates alone.

It thus seems that the AER is conflicted between a choice of conditional versus unconditional MRP and this appears to be the basis for suggesting an equally weighted average. One might quite sensibly wish to down weight the DGM MRP estimate because of concern about bias, or inaccuracy in the estimate, or a concern about construct validity. However, averaging with the HER estimate does raise an issue. Conditional and unconditional estimates are fundamentally different and averaging them is rather like averaging apples and oranges.

6. Cap and collar

The cap and collar approach may well have some merit. The merit is in avoiding sharp changes in the MRP that are largely or solely due to measurement error in the DGM. The latter being quite likely. The requirement that the cap and collar be symmetrical is not clear to us on a statistical basis. We presume that the CRG's desire for symmetry is to avoid an appearance of bias either towards the networks or toward consumers. Presumably the symmetry would be about some pre-chosen value for the MRP? In any case, the natural way to pursue this is by considering what the distribution of the estimated, conditional or unconditional MRP would be and construct confidence intervals with varying degrees of confidence. This would provide us with natural caps and collars that have some basis in statistical theory.

Below we discuss some of the issues involved in determining such confidence intervals. This leads us into a discussion of how autocorrelation in the estimates would affect the confidence intervals. We then discuss the nature and likely causes of observed autocorrelation in the data series.

The Confidence Interval Approach for Option 1.

The AER's option 1 is to use the HER as the primary determinant of the MRP.

We consider first what a confidence interval for option 1 might look like. In this case, we are using T observations on excess returns which would be the rate of return to the ASX200 accumulation index minus the riskless rate. The latter being either a 5 or 10 year rate.

We denote this at time t as

$$X_t = R_t - rfr_t$$

For simplicity we shall assume that R_t and rfr_t are bivariate normal so that X_t is normal; and $\mathrm{E}(X_t) = \mathrm{MRP}$ and

$$\sigma^2 = \mathrm{Var}(X_t) = \mathrm{Var}(R_t) - 2\mathrm{Cov}(R_t, rfr_t) + \mathrm{Var}(rfr_t).$$

As is well known, we can form a confidence interval on the MRP of the form,

$$\text{Prob}\left(\bar{X} - \frac{s\gamma_\alpha}{\sqrt{T}} < MRP < \bar{X} + \frac{s\gamma_\alpha}{\sqrt{T}}\right) = 1 - \alpha$$

Here *s* is the sample standard deviation, $\bar{X}$ is the sample mean of excess returns, in effect the HER estimate of MRP and γ_α is the appropriate point of the t-distribution with T-1 degrees of freedom.

Given we use no other information than the excess returns themselves, the MRP under consideration is the unconditional MRP. These calculations are based on assuming that historic excess returns are independently and identically distributed. However, if there was autocorrelation in the data, the formula for *s* could be adapted to accommodate this. Predominantly negative autocorrelation would reduce the value of σ^2; predominantly positive autocorrelation would increase the value of σ^2.

For nominal excess returns using an accumulation index with the ten year rates for Rf, T = 139 (annual data), s = 0.1617, $\bar{X}$ = 0.0615 and we shall set $\gamma_\alpha = 2$, giving us upper and lower limits and 8.89% and 3.41% respectively. These are clearly rather wide confidence intervals and reflect the substantial volatility of returns on the market.

Although, we could create some spurious accuracy by looking up precise values for the t statistic, there are so many reasons why this gain in accuracy would indeed be spurious that we prefer a robust approach to the choice of critical value. The choice of a 95% confidence interval is conventional.

The Confidence Interval Approach for DGMs

Given we have monthly data for MRP two stage five year, MRP three stage five year, MRP two stage ten year, and MRP three stage ten year rates, we can repeat the exercise; we report these as pairs. They are (0.0695, 0.0643), (0.0738, 0.0690), (0.0655, 0.0611) and (0.0701, 0.0655).

The MRP two stage five year rate, (0.0695, 0.0643), and MRP two stage ten year rate, (0.0655, 0.0611), both provide plausible cap and collar numbers and support the confidence interval approach.

The MRP three stage five year rate, (0.0738, 0 0690), and MRP three stage ten year rate, (0.0701, 0.0655), both provide rather less convincing cap and collar numbers, not because the widths of the confidence intervals are too large but because they are centred around a rather high mean.

Auto correlation and confidence intervals.

Given we use no other information than the excess returns themselves, the MRP under consideration is the unconditional MRP. These calculations are based on assuming that historic excess returns are independently and identically distributed. However, if there was autocorrelation in the data, the formula for *s* could be adapted to accommodate this.

Monthly historical returns show very little autocorrelation; however, all the evidence points to positive autocorrelation in interest rates, driven by the use of overlapping data. As a consequence, monthly excess returns, whether based on five or ten year risk free rates are positively autocorrelated, as would also be the case if the excess returns were calculated using overlapping data, and likewise HER estimates based on averages. Thus, confidence intervals could be wider than calculated in the earlier examples.

A further explanation of the high autocorrelations in interest rates depends on whether we use rates of return or yields. If we use yields, we are using a method analogous to the dividend discount model as the yield is calculated as the number that equates the current price to the coupon structure and final pay-off. Then a yield, based on annual returns but updated monthly will exhibit high and persistent autocorrelation, for the same reason *k2* and *k3* have high autocorrelation.

The difficulty in reconciling the *k2* and *k3* estimates with HER estimates is that they differ fundamentally, not least because of the fact that one is unconditional but also because of the differing sources of their autocorrelation. With non-overlapping monthly data for both ASX200 returns and 5 year and 10 year interest rates, most of the autocorrelation would disappear as in our results.

In the case of *k2* and *k3*, the autocorrelation comes from a different source. Each month, these variables are estimated using forward-looking annual data (forecasts). These numbers are highly correlated, but their correlation is likely due to the fact that the dividend forecasts overlap. If this is the case, then the correlation is not artificial but a consequence of the information flow. Consequently, the time series properties of HER and the DGM estimates are very different.

Five Year Rates versus Ten Year Rates in the case of Option 1.

As mentioned elsewhere we would expect the HER estimate of MRP to be larger for the five year rate than for the ten year rate in the normal situation of upward sloping yield curves. However, γ_α and T would be the same in both instances so that the width of the confidence interval, which is $\frac{2s\gamma_\alpha}{\sqrt{T}}$ will differ only in *s*. It is generally thought that yield curves become more volatile as we increase maturity but would need to be confirmed by analysis of the data.

The Confidence Interval Approach for Options 3a and 3b.

Option 3a and 3b use the equally weighted average of the HER estimate and DGM MRP estimates. The only difference between the methods is frequency of updating. We address these two models within the same analysis as their structures are very similar. As discussed in section 1, either model will give us a time-series which, omitting the initial term we denote by $k_1, k_2, \ldots$.. If we wish to combine these estimates to arrive at options 3a and 3b, there are a number of preliminary issues to be addressed.

Firstly, should we think of these numbers as conditional MRP's or unconditional MRP's? In our view, they are conditional MRP's as the values would change if we changed our GDP or dividend forecasts. This has the implication that option 3a and option 3b by taking weighted sums of averages involves adding unconditional MRP's to conditional MRP's. This is like adding apples to oranges. It is hard to think of a theoretical justification for this as these entities are fundamentally different.

Can we derive confidence intervals as was done in under option 1 above? Here, it is much more difficult as the distribution of the k's will follow non-linearly from assumptions about the joint distribution of dividend and GDP forecasts. Furthermore, the relationship is so highly non-linear that there is no known formula for the distribution, and we would have to resort to numerical methods. We conclude, therefore, that setting caps and collars for option 3 on a statistical basis will be very difficult, but not necessarily impossible.

If the basis of the cap and collar is not established statistically, it is not clear how it would be objectively established. Even with a statistical basis to inform choice of the cap and collar it would seem likely that the values chosen would become a matter of judgement and negotiation. Given our view that there is likely to be a lot of error in the DGM estimates, then we would judge a tight cap and collar to be appropriate.

7.The Calibrated DGM.

The first point we would make is that the estimate from the ENA calibrated DGM, the estimates from Fenebris, and the estimates from the AER, provide a clear demonstration of the different magnitudes for the MRP that DGM models can give you depending on the model that you use.

We outline some features of the calibrated DGM. The way it is used is to fix *k*, set the expected total return of the market as a constant based on a historical HER value and determine g. Fixing *k* however has some implications. Suppose the period in question runs from *t* to *t*+n. We note that *k* = $MRP_{t,t+j} + rfr_j$.

For *j* = 1,…,n, where $MRP_{t,t+j}$ is the conditional MRP at time *t*+*j* conditional on information at time *t,* whilst rfr_j is the corresponding five year risk free rate at the same time .Both these terms are variable but their sum, *k*, is constant. This will imply that there is a correlation of -1 between the two variables so that, in this framework, we might expect to see negative correlations for derived values. Indeed a 1% increase in *rfr* leads to a 1% fall in $MRP_{t,t+j}$ and vice-versa. This is generic in the sense that it will be true whenever *k* is fixed.

Advocates of the calibrated DGM argue that it provides a means to compare the current (conditional) MRP with the historical unconditional MRP. Given our concerns about what these DGM estimates actually mean, it is questionable how useful this is.

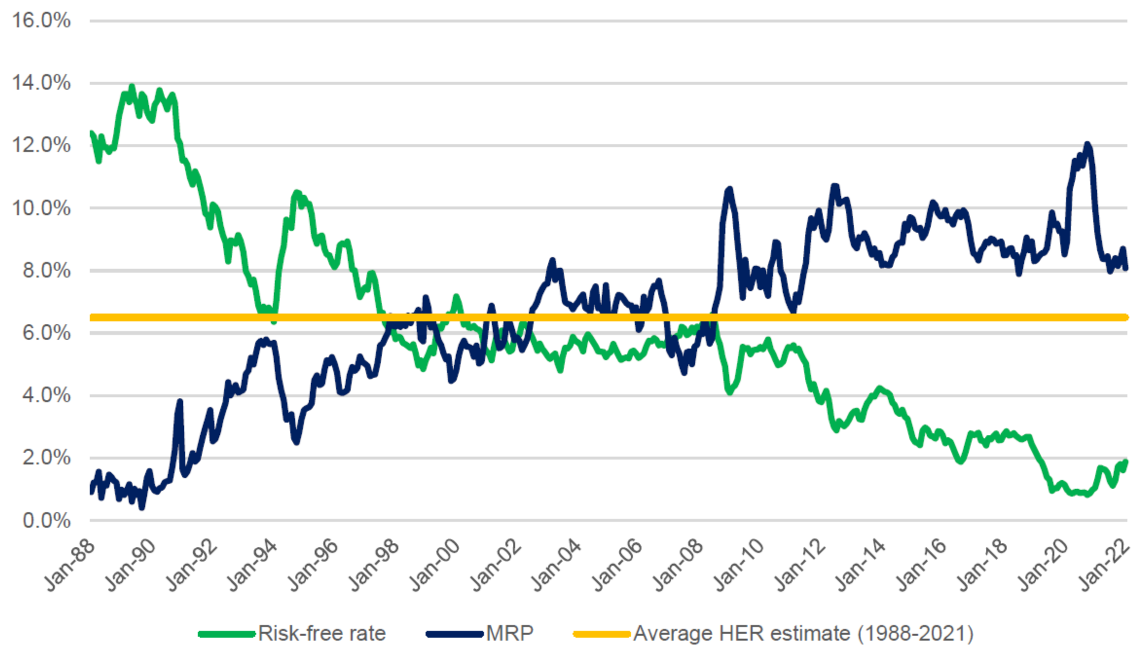
We reproduce below Figure 7.2 from p.145 of the AER's explanatory document for the draft determination. Compare the variation in the MRP in this figure 7.2 from 2006 onwards with the variation in the MRP from the AER's estimates in Figure 1. There is a remarkable similarity between the two MRP series, indeed we are tempted to say that the pattern of variation is identical, but we would need the numerical data to be sure. The main difference in the two MRP series is that the estimate from the ENA calibrated DGM has higher peaks, higher troughs and a higher mean. We hypothesise that the MRP estimate based on the ENA Calibrated DGM could be replaced by our regression model for the MRP, but we would need to increase the value of the intercept. We conjecture that this result may have come about because the MRP estimates have been generated by the AER with their model but using the 6.023% long run growth rate from the ENA model. In which case we are simply seeing the effect of changing the growth rate on AER estimates.

As the AER points out the ENA calibrated DGM has an extreme range of variation in the MRP from 0.04% to 12.05%. It is difficult to regard this as credible and we agree with the AER's conclusion that p.145:

> *... we do not think the results produced by the model can be credibly applied to our rate of return.*

If our conjecture about the basis of the estimates for the ENA's calibrated DGM are correct, then the foregoing quote comes dangerously close to damming the AER's own model.

Figure 7.2 MRP estimates produced by ENA's calibrated DGM



Source: AER analysis; ENA calibrated DGM results; RBA interest rate statistics f16.

8. Term for the estimation of the return on equity

The principle of matching the term of the discount rate to the maturity or duration of cash flows is well established and widely used in bond markets. Term matching is standard practice in pricing bonds since the term structure of interest rates can be observed. When it comes to valuing businesses or physical assets trades are infrequent, and specification of cash flows is difficult. Thus, the data conveniently available in bond markets to match discount rates to maturities is not conveniently available to value businesses. Resort is instead made to determining the rate of return on the securities issued by the business. The discount rate on those securities is then used infer the discount rate that should be used in valuing the business and its assets. Hence the use of the well-known weighted average cost of capital (WACC).

In formulating the WACC it is necessary to form an estimate of the cost of equity. The usual way to do this is by using the CAPM. This requires selection of an appropriate risk free rate. There has been extensive argument in favour of using the treasury bill rate (treasury note rate in Australia) for this purpose, since it is the closest thing to a truly risk free rate. Thus, there is an argument for using an even shorter maturity for Rf than the currently proposed five years. The counter argument to the use of the treasury note rate is that equity has a long life and is used to finance long lived assets. Therefore, a long term measure of the risk free rate should be used. The trade-off is between the measurement error from having a riskier proxy for Rf and the measurement error from having a proxy for Rf poorly matched to the term of the investment. The argument in favour of a long term measure for Rf has prevailed in practice.

If a long term rate is used, it would seem logical to match the risk free rate to the duration of equity for the firm. This however is not done because of practical difficulties. On pragmatic grounds the 10 year government bond rate is used. This is because an active and liquid market provides reliable estimates of current yields. As the foregoing discussion shows, the argument in favour of using a ten year term rests not on a tight theoretical foundation but rather more strongly on it having passed the test of time in the practice of valuing assets and companies.

The AER is not in the business of valuing assets or companies, but rather with setting an allowed rate of return for a five year regulatory period consistent with the zero NPV investment criterion. The past use of a ten year value for Rf in determining this rate of return has presumably been based on acceptance of the view that equity is a long lived security and that the networks clearly have long lived assets and also that the use of a ten year term for Rf is standard practice.

None of this, however, necessarily means that the use of the ten year value of Rf is correct in the regulatory setting.

This question of the appropriate term for the cost of equity to be used in regulatory settings has been carefully examined by Martin Lally. For quite some time he has made the case that the term of the return on equity should be matched to the regulatory period. This case was recently made to the AER in: *The appropriate return for the allowed cost of capital*, M. Lally, 2021. We have carefully reviewed Section 2 of his document where the appropriate term for the return on equity is analysed. We can find no fault with the analysis in Section 2 of Lally's paper and so must endorse it, but as we discuss below we still remain uneasy about the switch to a five year term.

In relation to the AER's 2022 Concurrent Evidence Session's discussion of this topic, Glen Boyle also endorsed Lally's result. As Boyle succinctly put it:

> *In the absence of some compelling reason for overturning the standard paradigm, date **t** cash flows **must** be discounted at the date **t** expected return.*[19]

It is difficult to disagree with this observation.

An intuitive explanation in support of Lally's conclusion follows. The current value of a network is equal to the present value at $t = 0$ of the cash flows over the five year regulatory period plus the present value at $t = 0$ of the market value of the network at the end of year five. All the expected cash flows (which depend on future regulatory decisions) and the discount rate(s) that apply beyond year five are reflected in the market value at the end of year five.

The regulator's current decision concerns the increment in value over the present value at $t = 0$ of the market value of the network at the end of year five.

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[19] Boyle, G. 2022, p.1, *Some comments on the notes circulated by Dinesh Kumareswaran and Graham Partington*, Commentary in relation to AER Concurrent Evidence Sessions.

This depends upon the cash flows over the next five years. The objective is to set the cash flows so that investing in those cash flows is a zero NPV investment. In other words, the present value of the five years' cash flows should equal the investment. This is achieved by setting the allowed cash flows using the market discount rate appropriate to a five year term.

We conclude that matching the term of the cost of equity to the term of the regulatory period is consistent with finance theory. The principle is sound, but there remains the issue of measurement.

If we knew what the term structure of equity was then we could simply take the five year cost of equity given by the term structure. However, the understanding of the term structure of equity is currently such that we cannot even be sure if there is a term structure. This leaves open the question of what the five year cost of equity should be. The AER's solution is to measure the five cost of equity using the five year yield for Rf and recomputing the historic equity risk premium (HER) using five year rather than 10 year government bond yields. This has the merit of consistency in the term of inputs to the estimation of the cost of equity and is also consistent with the approach the AER previously used for the ten year term.

The measurement approach, however, assumes that there is a term structure to the equity market risk premium, and also one which is appropriately measured by the method the AER follows. For example, it might be the case that the cost of equity is a constant whatever the term, or perhaps it is more or less flat for terms of say more than a year. In which cases the equity rate of return for a five year term and a ten year term are the same. The question then becomes, whether the five or ten year approach to measurement give the best estimate for the constant equity rate of return.

In summary, the AER's change of term adopts a principle that is consistent with regard to finance theory. The AER's measurements in implementing that principle are sensible but whether the best measurements are being used is an open question. We support the logic of Lally's analysis; however, we feel uneasy about the divergence from a well-established method in estimating the cost of equity both in practice and by the AER. With respect to the latter, the CRG has advocated for a high bar to change, and the question is whether the case for change is strong enough.

Appendix A

Background to the Project

The AER has published its Draft rate of return instrument and an Explanatory Statement setting out the reasons for its preferred positions. For details of the AER's 2022 RoRI process, see https://www.aer.gov.au/publications/guidelines-schemes-models/rate-of-return- instrument-2022
Following the publication of the draft instrument and explanatory statement, the AER has retained an option (though its preference is still to maintain its HER-based approach) to implement a formula for MRP that can be used to mechanically calculate an MRP to be updated each calendar year and applied to each regulatory determination made in that year. The specific outcome will depend on the length of the regulatory period for that specific determination (usually five years). The formula is:

• 50% weighting to HER data, based on the arithmetic average from 1988 to the most recent complete calendar year.
• 50% weighting to DGM data, based on the AER's existing three-stage DGM.

The detailed specification of the DGM and how the annual update would be carried out are set out in Appendix 1 below and on pp 150-151 of the AER's Draft Explanatory Statement.
The CRG is interested in better understanding the implications of this option for determining the level of the MRP.
The CRG is also seeking advice on the AER's approach to term. The AER has received a report from Dr Martin Lally in which he argues that the only way to meet the NPV=0 criterion is to select a term for the return on equity that is equal to the length of the regulatory period (typically 5 years). The AER is persuaded by Dr Lally's arguments despite countervailing views expressed by stakeholders and experts and has proposed to change the term from its long-standing benchmark of 10 years.
In practice the only consequence of the AER adopting Dr Lally's approach appears to be a change the term of the risk free rate (RFR) it will use when estimating the overall return on equity under the AER's preferred model of the Sharpe-Lintner CAPM. Moreover, there is a consequent adjustment to the MRP since both the HER method and the DGM method are based on estimating the total market return and deducting the relevant risk free rate to obtain the MRP estimate. A 5 year RFR is typically lower than the 10 year RFR, consistent with finance theory. The corollary of this is that the MRP is *higher* under the 5 year term than the 10 year term. Furthermore, the AER is proposing its estimate of beta will remain invariant to its term decision. As a result, the ERP (MRP x beta) is also higher under a 5 year term rather than a 10 year term. The CRG is interested to understand whether these outcomes are consistent with finance theory.
3

Project objectives and specifications

The CRG is seeking to contract an independent expert to provide advice on the above, and document this advice in plain English, to assist the CRG in furthering its understanding of:

· the potential variation in estimates of the MRP derived from the AER's 3-stage model;

· whether the AER's 3-stage model provides the best estimate of the DGM in the context of the AER's proposed use of the DGM in the 2022 RoRI, and

· whether the AER's approach to term is consistent with finance theory.

In particular we would like to understand:

Sensitivity analysis

1. The plausible range of outcomes of the DGM calculation. We'd envisage this being based on deriving ranges for the variable inputs: the risk free rate, the current dividend yield, short-term dividend forecasts and the long-run growth rate. Our initial thoughts on how to derive ranges would be to look at historical variations. This would potentially require access to the relevant proprietary data series from Bloomberg and Consensus Economics. If this presents difficulties, there may be an alternative where we ask the AER to perform the relevant analysis and then share that output with the expert for evaluation. If this is the preferred approach please contact us to discuss. We'd expect the fee to be lower if the AER was carrying out the underlying analysis
2. The implications for the plausible range of changing some of the components of the DGM

that the AER has assumed are fixed. These would include their choice of 3 stage over 2 stage estimates and the choice of a 1% discount on the long term GDP growth rate to arrive at a long term dividend growth rate. We would also seek some commentary on whether the AER's choices could be evaluated as better or worse than the alternatives.

Stability analysis

3. The AER claims that on their assessment (which only varies the RfR), Option 3(b) (HER & DGM) provides more stable RoE results when compared to Option 1 (HER only). Stability is important to consumers. However, this result is not surprising given the AER has come to the stability conclusion with reference only to variation in the RfR, which is not a component of the DGM. The AER has not considered the impact of variations in the components of the DGM (as per 2 above). When accounting for such variations, does Option 3b still provide more stable RoE results than Option 1, and if so, to what extent? What difference does the AER's choice of 5-year RFR rather than a 10 year RFR make to the stability of RoE results?

Desirability of a cap and collar

4. If the extremes of the plausible range of MRP estimates are materially different from the range of 6-6.5% that the AER has used over three rate of return reviews (2013, 2018 and the draft 2022), then there is some question over the sustainability of the approach. The CRG assumes that very low MRPs would be heavily challenged by the networks. Conversely very high MRPs would have marked consequences for consumers. Without being definitive about the acceptable range, the CRG is seeking commentary on the merits and practicalities of applying a cap and collar to the DGM estimate (our starting point is that any such limiting mechanism must be symmetric).The CRG would welcome any other comments on the AER's Option 3(b), and the AER's rationale for preferring this option over alternative approaches to the calculation and application of the DGM.

5. In this context, we also seek comment on whether the calibrated DGM proposed by the ENA/Frontier addresses these matters, and whether this is a preferable approach given the limitations that the AER has outlined with respect to the calibrated DGM.

3

Reference information

The Consumer Reference Group (CRG) was appointed by the AER in June 2020. Its role is to help the AER implement an effective consumer consultation process during the development of the 2022 Rate of Return Instrument (2022 RoRI). Further details of the CRG can be found on the AER's website at https://www.aer.gov.au/about-us/stakeholder- engagement/consumerreference-group

While this project will be conducted independently of the AER, we expect the CRG and the Consultant could engage with the AER as the project progresses.

Energy Consumers Australia (ECA) is funding this project and will be closely involved in its oversight. For details of the role and functions of the ECA, see https://energyconsumersaustralia.com.au.

The AER's 2022 RoRI decision must satisfy the National Electricity Objective (NEO), the National Gas Objective (NGO) and the Revenue and Pricing Principles (RRPs) set out in the National Electricity Law (NEL), the National Gas Law (NGL).[1]

The AER's RoRI decision must also satisfy the relevant provisions in the National Electricity Rules (NER) and the National Gas Rules (NGR) [2] In undertaking this project the Consultant must take account of the relevant statutory requirements and, in particular, the National Energy Objectives (NEO and NGO) and the Revenue and Pricing Principles (RPPs) set out in the NEL and NGL.

Appendix 1: The AER's three stage dividend growth model and the annual update process

a) The DGM

In the 2013 Guideline and 2018 Instrument we arrived at a version of the DGM we considered was best suited to our regulatory task:

$$P_c = \frac{m\ x\ E(D_c)}{(1+k)^{\frac{m}{2}}} + \sum_{t=0}^{n} \frac{E(D_t)}{(1+k)^{m+t-0.5}} + \frac{\frac{E(D_N)(1+g)}{k-g}}{(1+k)^{m+N-0.5}}$$

Where:
• P_c is the current price of equity, for which we use the S&P/ASX 200 index as the proxy
• (D_c) is expected dividends per share for the current financial year301
(D_t) is expected dividends per share for the financial year, t years after the current financial year
· m is the fraction of the current financial year remaining, expressed as a decimal point
· N is the time period after which dividend growth reverts to its long-term rate (for the 2-stage model N = 2, for the 3-stage model N = 9)
· g is the expected long-term growth rate in nominal dividends per share
· k is the expected return on equity for the market portfolio.
Source: Explanatory Statement pp142-143

b) the annual update

To update this model, we would: − obtain the dividend forecasts and the share market price index from Bloomberg
− obtain the risk-free rate data from the RBA We will use the indicative mid rates of Australian Government Securities – F16 to calculate the risk-free rate.
− estimate the Australian nominal GDP growth rate and the inflation forecast using the most recently published Consensus Economics (CE) long-term forecast data for Australia (APCF LT Australia) – we would use the most distant forecasts available for years from 1 to 10 years in the future and these estimates will be used to reflect the current market environment.
− make a 1% deduction to the long-term real GDP when estimating the terminal dividend growth rate to account for new capital
− use the average estimates produced by the DGM over a period of 2 months.
- recalculate these estimates based on the dividend price forecasts and the share market price index information from Bloomberg, the risk-free rate data from the RBA and the latest reports from CE at the time of each determination – if any data sources cease to be available, the last 2-month MRP estimate would be fixed until data becomes available again
− use a 10-year CGS rate in the model to calculate a 10-year MRP
− calculate a 5-year MRP estimate from the DGM by reducing the 10-year MRP estimate by our estimate of the difference between the 10-year and 5-year MRP from HER data over the period from 1988 to the last full year available.

Source: Explanatory Statement pp 150-151