REPORT TO THE ERA:

THE COST OF EQUITY AND ASSET PRICING MODELS

By Graham Partington and Stephen Satchell

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Author’s Credentials

This report has been prepared by Associate Professor Graham Partington and Professor Stephen Satchell. We are senior finance academics who have published several books and many research papers in finance and we have extensive consulting experience, particularly with respect to the cost of capital and valuation. Our *curriculum vitae* can be found in Appendix 2.

We have read “Expert witnesses in proceedings in the Federal Court of Australia” which are attached as Appendix 3. This report has been prepared in accordance with those guidelines. An expert witness compliance declaration can be found following the reference list at the end of our report.

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The context of the report

The ERA has approached us with a request for advice in relation to the cost of equity. The issues to be addressed are given below and the full terms of reference are given in Appendix 1.

Scope of work

This consultancy seeks to evaluate, *in terms of the requirements of NGR 87*:

- the relative strengths and weaknesses of estimating the forward looking return on equity, in an Australian context, using the Sharpe Lintner CAPM or the Black CAPM, or some combination of those models, including;
  - the utility of the ERA's adjustment to the beta for its estimate of the return on equity from the Sharpe Lintner CAPM, informed by the theoretical insights of the Black CAPM;[1]
  - the utility of DBP's approach to estimating the return on equity using empirical results from the Black CAPM, 'transformed' into the Sharpe Lintner framework;
- the utility of DBP's empirical 'model adequacy test' in validating those strengths and weaknesses;
- which approach for estimating the return on equity best meets the requirements of the National Gas Rules;
- if there is anything further that the ERA should be aware of in forming its view as to the alternate approach for estimating the return on equity?

Key tasks

The consultancy is split into two stages:

- the first stage will involve evaluating the relevant material and drafting a report which addresses the key requirements (see below); and
- the second stage would involve any extension analysis which is deemed relevant to providing additional evidence to support the Authority's decision on the issues in its final decision.

Key requirements for the consultant in the first stage include:

- familiarising with the range of relevant materials identified in the 'Introduction' section above;
- responding to the criticisms of Partington and Satchell set out by DBP and its consultants Competition Economist Group, HoustonKemp, and in so doing:[2]
  - responding to the DBP's critique that the ERA incorrectly relies on the views of experts such as Partington and Satchell:[3]

[1] By 'utility' we mean the ability of the approach to meet the requirements of NGR 87, including the allowed rate of return objective. The ERA in its gas Rate of Return Guidelines noted a range of criteria which allow it to 'articulate its interpretation of the requirements of the NGL and NGR' (see Attachment 1).

[2] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, pp. 42 - 43.

> *…as being supportive of its own view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust.*

- evaluating DBP's approach for estimating the return on equity using the Black CAPM, given the arguments set out both in its initial proposal and in its revised proposal, including;[4]
    - ♦ DBP's contention that the model adequacy test overcomes the problems associated with the robustness of the Black CAPM approach; and
    - ♦ that aspects of the ERA's own zero-beta premium estimates (for example, all being greater than zero, or, are incorrectly calculated) do not lend support to rejecting the DBP approach;[5] and
    - ♦ that the resulting DBP Black CAPM estimates of the return on equity are unbiased;[6]
- evaluating the ERA's approach for estimating the return on equity using the Sharpe Lintner CAPM, which takes account of the theoretical insights of the Black CAPM;
    - ♦ particularly DBP's contention that the Sharpe Lintner CAPM, even with beta adjusted to the top of its confidence interval range, remains downwardly biased;[7]

• writing a report which integrates this analysis into a recommended way forward for the ERA in terms of estimating a return on equity which meets the requirements of the NGL and NGR;
    - scoping any further econometric or analytical work for a potential second stage that might be required to support that recommended way forward.

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[3] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, pp. 42 – 44; and
DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, Appendices F, G and H.
[4] This evaluation should account for the econometric and statistical analysis of Data Analysis Australia and Esquant Statistical Consulting referenced in the Introduction above.
[5] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, pps. 41 - 42.
[6] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, p. 65; and
DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 41.
[7] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, p. 63.

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Introduction

In this report we discuss the issue of cherry picking and the strengths of the SL CAPM in this context. We also explain that there are substantial theoretical and practical difficulties that are involved in the estimation of the zero beta return, or zero beta premium, and there are a potentially infinite set of values that might be obtained. Consequently, the Black CAPM is wide open to gaming of the regulatory return.

We demonstrate that there are substantial econometric problems in the estimation of the zero beta return and that what you get is very much influenced by what you do in the estimation process. Consistent with our arguments, it can readily be observed that there are widely varying empirical estimates of the zero beta premium.

We discuss problems with model adequacy tests and we point out that when portfolios are based on industries the SL CAPM passes the model adequacy tests. We also discuss whether it should be accepted that the so called "low beta bias" really exists, or whether it is more appropriate to consider this an issue of over-performance that relates to "alpha". We also show that in a time series context a negative correlation is expected between estimates of beta and the intercept.

We respond to the criticism of the prior work of Partington and Satchell and show that it has little or no merit. We follow this with a summary of six reasons why the zero beta (Black) CAPM is not appropriate for use in determining regulated returns. We also explain that the SL CAPM has passed the test of extensive use in practice for several decades and that contrary to the assertions of DBP and its consultants the zero beta (Black)CAPM has not had use in practice .

As we explain later the term Black CAPM covers several different models which involve the return on a zero beta portfolio. We therefore prefer the term zero beta CAPM as descriptive of these models. However, for consistency with the documents that we have reviewed we will use the term Black CAPM in this report.

Model adequacy tests

We begin by making some general comments about model adequacy test, with more technical issues covered in later sections of our report. Our reading of DBP (2016) submission in relation to model adequacy tests is that this is a masterpiece of marketing that could easily lead the unwary reader into believing that the purpose of asset pricing models was to forecast returns and that therefore the test of an asset pricing model's adequacy is whether it predicts subsequent returns. So let us be absolutely clear that the purpose of asset pricing models is to determine the ex-ante return that investors require. When prices are in equilibrium this required return is equal to the expected return, but there is no guarantee that expectations will be realised, or that prices are always in equilibrium. If there were a guarantee that expectations would be realised then the asset would have no risk. The consequence of the foregoing for asset pricing tests is well expressed by Davis (2011, p3):

"The required returns are also referred to as expected returns by financial economists by relying on an assumption that asset prices equilibrate in efficient markets through supply and demand influences. If, given the current price of an asset, investors' expectations about future cash flows or future market value of that asset imply an expected return different to their required return, they will buy or sell that asset causing its price to adjust until it equates expected and required returns. Thus, the theories are simultaneously theories of equilibrium asset prices and required and expected returns. The theories do not purport to fully explain actual returns, since these can differ from expected returns due to a variety of factors including news about future cash flows which cause investors to reassess the appropriate price of an asset. If actual returns are a poor proxy for expected returns, the ability of a theory of expected returns to explain actual returns may be limited."

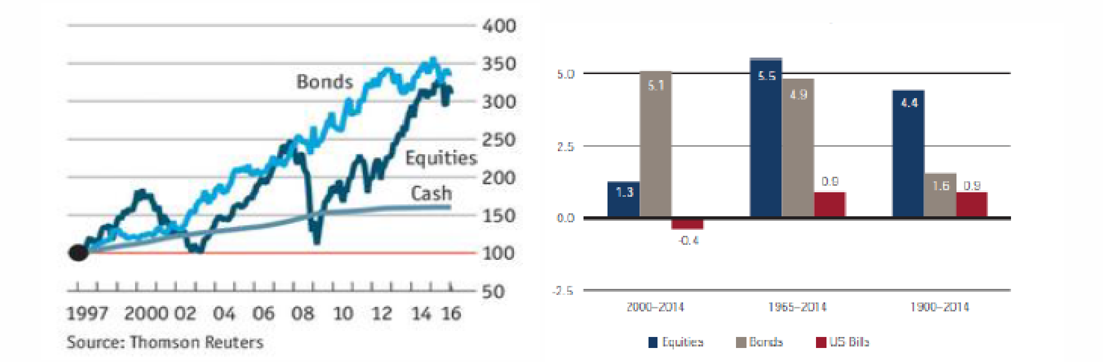
As shown in Exhibit 1 below, DBP (2016) in defence of their results for Portfolio Nine make the same argument as above. The material in Exhibit 1 also amply demonstrates that actual returns do differ from expected returns for very long periods of time. No rational investor invests in shares expecting decades of negative real returns, or expecting that bonds will outperform equities, yet these were actual outcomes. Thus differences between expectations and outcomes are a major problem for tests of asset pricing models.

Exhibit 1: Difference between expected and realised returns (sourced from DBP (2016, p46))

"Elroy Dimson, Paul Marsh and Mike Staunton of the London Business School are the acknowledged experts on global investment returns, having compiled data covering 22 countries over more than a century. As of February 2013, the longest period of negative real returns from US equities was 16 years. But it was 19 years for global equities (and 37 for world ex-US), 22 for Britain, 51 for Japan, 55 for Germany and 66 for France. Such periods are much longer than most small investors would have the patience to wait."

6.85 The same article points to the work shown in the left hand side of Figure 4, suggesting that bonds have actually out-performed equities over recent periods of time, and Dimson, Marsh & Staunton (2015) show similar evidence in the figure on the right hand side of Figure 4. Finally, Bloomberg, tracking returns on debt and equities over successive 30-year windows note that, in the 30 years to 2011, debt in fact did better than equities in the US.[62]

Figure 4: Debt and equity returns through time



Source: LHS http://www.economist.com/blogs/buttonwood/2016/01/investing, RHS, Dimson, Marsh & Staunton (2015) p60. Note that the left hand side is global bonds and equities, and the right hand side is for the world exclusive of the US

6.86 This is not to say that debt is somehow a better investment than equity, and that one ought to expect that debt will out-perform equity in any particular period. Rather, it is to point out that the ERA's "impossibility" finding in relation to the relative returns of debt and equity is incorrect; if periods can be found where debt out-performed equity, then it is not automatically nonsense that Portfolio Nine has lower actual returns for equity than what the ERA believes are promised debt returns, particularly when Portfolio Nine is one of the riskiest portfolios we examine.

When the equity market has negative returns, low beta stocks are expected to perform better than high beta stocks. Thus, ex-post a negative relation between beta and returns would be expected and vice versa when the equity market has positive returns. Indeed Isakov (1999) argues that tests of the CAPM should be conditioned on the sign of the excess return on the market and shows that when this is done beta is a highly significant predictor of returns with the signs of the coefficient as expected, positive when the excess return is positive and negative when the excess return is negative. Whereas, when there is no conditioning on the sign of the excess return on the market there is no relation between beta and expected returns. We are not arguing that conditioning on the sign of the excess return provides a good test of the CAPM,[8] but merely that differences between expected and realised returns are a problem when testing

[8] The results are conditioned on ex-post information and had investors known this information they would have had different expectations and they would have set different prices. As a result the returns would differ from those observed.

asset pricing models. This result also illustrates that what you get when testing asset pricing models is strongly influenced by what you do.

The latter point, that the results of tests of asset pricing models depend very much on what is done in the test, is amply demonstrated by Lewellen, Nagel and Shanken (2010), and Kan Robotti and Shanken (2013), who show that the results of asset pricing tests using realised returns vary substantially according to how the portfolios used in the tests are constructed and also on the restrictions placed on the estimate of the intercept. They also illustrate that there is ongoing debate about the appropriate statistical tests that should be used in assessing the performance of asset pricing models.

Llewelyn, Nagel and Shanken (2010, p183) express concern about the unreasonably high zero beta return estimates that come out of many asset pricing tests. They state:

"Most clearly, theory says the zero-beta rate should equal the risk free rate. A possible retort is that Brennan's (1971) model relaxes this constraint if borrowing and lending rates differ, but this argument isn't convincing in our view: (riskless) borrowing and lending rates just aren't sufficiently different – perhaps 1–2% annually – to justify the extremely high zero-beta estimates in many papers."

We fully concur with this view.

The relative strengths and weaknesses of estimating the forward looking return on equity, in an Australian context, using the Sharpe Lintner CAPM or the Black CAPM, or some combination of those models

Where asset pricing models in addition to the SLCAPM are used, the Queensland Council of Social Services (QCOSS, 2015) expressed a concern about the risk of cherry picking. In response to this expression of concern Partington (2015) made the following statement:

Even with the best will in the world, there is a natural inclination to select the parameters that favour self-interest as being the truth, so there is a natural tendency towards cherry picking. As a test of this we propose the following hypothesis: Where a choice of parameters are available, the regulated businesses will tend to select the values resulting in a higher rate of return and those *groups representing users will tend to select the values resulting in a lower rate of return. This hypothesis is well supported by the submissions that we have been asked to review.*

As an on-going test we have carried this hypothesis forward across our reports and we find that the hypothesis is consistently supported by the evidence from submissions of both regulated businesses and user groups. The current submissions that we have been given to review are only from one regulated business, DBP, but the hypothesis above continues to be well supported. In this context an advantage of the SLCAPM is that it is a parsimonious model. The required input is confined to one variable and two parameters, one of which is taken to be the return on government debt and so is directly observable. Parsimony and observability reduces opportunities for cherry picking and also provides the opportunity for a relatively transparent implementation of the model.

To the extent that an asset pricing model's estimates are well founded, unbiased and appropriately combined, in principle there could be merit in combining models. However, as subsequent discussion will make clear we have significant reservations about the implementation of the Black CAPM. We also have the familiar problem that once we start combining models, the process becomes gameable. It is rational for regulated businesses to choose weights for the combination such that the cost of capital is increased. This can be done by a variety of arguments, many of them basically arbitrary, but the tendency is to down-weight the SL CAPM.

In the case of DBP the reweighting is indirect in that they use the zero beta premium estimate to adjust the beta in the SL CAPM which they call their Betastar model. Betastar is calculated according to the following equation:

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

where $\hat{z}_{0t}$ is an estimate of the zero-beta premium, $\hat{z}_{mt}$ is an estimate of the market risk premium and β_{jt} is an estimate of the beta of portfolio *j*, all terms being computed using data from before month *t*. This adjustment transforms the SL CAPM to give the same result as the Black CAPM. Effectively, therefore the Black CAPM has replaced the SL CAPM in the DBP Betastar approach. This approach, therefore, has all the deficiencies of Black CAPM as discussed in this report and is therefore not suitable for regulatory use.

It is understandable that it is attractive to regulated businesses, to place as small a weight as possible on the SL CAPM as this model tends to give the lowest estimate of the return on equity. However, giving the SL CAPM a low weight is difficult to reconcile with the observation that the SL CAPM is the one model that has had widespread use in practice for estimating the cost of capital, a property that the other models do not enjoy. As Partington and Satchell (2015, p21) state:

"…the CAPM has passed an important test. That test is the test of time. While academics are still debating the merits of the different asset pricing models, how they should be tested and what the appropriate test statistics are, the users of models have made up their mind about which model to use when estimating the cost of capital. The SLCAPM has had several decades of widespread practical use in estimating the cost of capital. None of the other models have passed the same test."

In Partington and Satchell (2016) referring to the zero beta (Black) CAPM we extend the foregoing quote and add: "This contrasts with the HoustonKemp's (2016a) zero beta CAPM with no track record of use in practice, and in our opinion it is a model that is never likely to have significant use in practice."

CEG (2016, p 27) quotes Professor Handley's observation that the Black CAPM is "not widely adopted in practice" and seeks to dispute this. We support Handley's observation. As we discuss below we have seen no convincing evidence that the Black CAPM has had any use outside of regulatory purposes. We also note that CEG conflates the adjustment for mean reversion in beta (the Blume adjustment) with the Black CAPM. The Blume adjustment is an adjustment for potential estimation error where low estimates of beta may tend to be underestimates and high estimates of beta may tend to be overestimates. Thus over time as the estimation error diminishes, the betas drift back towards one. This is solely to do with the estimation of beta and has nothing to do with the Black CAPM. This is a significant point as the Black CAPM diverges from the SLCAPM due to the intercept term. Adjustments, if any, would therefore appropriately be made to the intercept rather than to security betas.

Considering the use of the Black CAPM in practice, one of the authors of this report has been a quantitative consultant for over 25 years and has advised many scores of top level 'quant' teams in the finance industry. Whilst he has seen applications of both the SL CAPM and variants of the

Fama and French model on many occasions, he has never seen a single application of the Black CAPM. The other author has been researching and consulting on topics relating to corporate finance, including valuation, the cost of capital and capital budgeting for more than 35 years. In particular he has surveyed companies on their capital budgeting practices and how they determine their cost of capital and he has read many capital budgeting surveys and surveys of valuation practice. In all this material there has never been any evidence that corporates estimating their cost of capital, or financial experts doing valuations, have used the Black CAPM. Neither, in the many submissions from regulated businesses and their consultants that we have read over the years, have we seen any convincing evidence of use of the Black CAPM in business. As we have previously commented, McKenzie and Partington (2012):

"Having reviewed the arguments supporting the NERA (2012) conclusion that the Black CAPM is a well accepted financial model, we conclude that the NERA report is not so much drawing a long bow, but rather more ambitiously it is trying to wind a Greek ballista. The argument will not make the distance that has to be traversed."

We would make the same comment about the CEG (2016) claims for use of the Black CAPM in practice. However, we do agree that some regulators in the USA have used the Black CAPM. One interpretation of this phenomenon is that the regulated businesses have realised that applications of the Black CAPM can lead to higher regulatory returns and have bombarded regulators with the model to the point that the regulators have (mistakenly) come to attach some importance to it.

The utility of the ERA's adjustment to the beta for its estimate of the return on equity from the Sharpe Lintner CAPM, informed by the theoretical insights of the Black CAPM

As we mention in the introduction, the term Black CAPM encompasses several models and it is important to be clear about which model we are discussing as each model has different implications. A common starting point for discussion of the Black CAPM is that it relaxes the assumption of unlimited borrowing and lending at the risk free rate in the SLCAPM. This may be considered an unrealistic assumption, but the alternative that Black (1972) proposes is also unrealistic, as Black himself acknowledges (p.466):

“Let us start by assuming that investors may take long or short positions of any size in any risky asset, but that there is no riskless asset and that no borrowing or lending at the riskless rate of interest is allowed. This assumption is not realistic, since restrictions on short selling are at least as stringent as restrictions on borrowing.“

The implications of this case is that the zero beta return must be below the return on the market. However, in the case of the Black CAPM it makes no sense to talk about a zero beta premium (the difference between the zero beta rate of return and the riskless asset rate of return) as no riskless asset exists. Therefore this model does not seem to be in contemplation by DBP as they utilise a zero beta premium. This also does not seem to be the model in contemplation by the ERA (2015) as they conclude that p.153 that the Black model assumptions are no more realistic than the SL CAPM. We concur with this view.

The next alternative that Black (1972) develops is based on the Vasicek (1971) model where there is a riskless asset and investors can take unlimited long and short positions in risky assets but are not allowed to short the riskless asset (borrow). In this case the zero beta return is more than the risk free rate and less than the return on the market. As McKenzie and Partington (2014) point out not only are there limits on short positions, but also short selling is a costly and risky business. Thus, the Vasicek model assumptions are only a little more realistic than the basic Black model.

The third alternative is the Brennan (1971) CAPM, where there are different borrowing and lending rates and investors are unconstrained with regard to short-selling. In this case the zero beta return must lie between the borrowing and lending rates. This appears to be the model in contemplation by DBP as they state (2016 p.51):

“As the ERA points out elsewhere (see DDA4 para 722, p152), the only theoretical difference between the SL-CAPM and the Black CAPM lies not in beta, but on the intercept; the Black CAPM assumes borrowing and lending rates differ and do not equal the risk free rate, but unlimited short and long positions are available, whilst the SL-CAPM assumes unlimited borrowing and lending is possible at the risk free rate. The practical effect of the theoretical change is to shift the intercept of the security market line upwards and thus lessen its slope. This, in turn, makes the expected returns of low beta stocks higher and of high beta stocks lower than predicted by the SL-CAPM.”

We should point out that the borrowing and lending rates are risk free rates, but the rates differ. In this case we can identify two possible market portfolios, one determined by the tangency point of a line between the risk free lending rate and the efficient set and one determined by the tangency point of a line between the risk free borrowing rate and the efficient set. The market portfolio in equilibrium is a combination of these two portfolios weighted according to the cross-sectional distribution of borrowers/lenders in the riskless asset. The distribution being determined by the wealth of the investors and their level of risk aversion. The likely outcome therefore is a security market line that is flatter than that given by the lending rate, but steeper than that given by the borrowing rate. The zero beta rate is constrained to lie between the lending and borrowing rates and hence the zero beta premium must be no greater than the spread between the lending and borrowing rates. This spread, even basing it on a borrowing rate that is not risk free (the yield on A rated bonds), is several times less than the zero beta premium being proposed by DBP.

The implication of the Brennan (1971) model is that the intercept in the model is likely to be higher than the risk free lending rate which is also the implication of the Vasicek (1971) model. Consequently if any adjustment is to be made on theoretical grounds the natural choice would be to adjust the intercept. Thus the correct theoretical adjustment is to increase the risk free rate to approximate the zero beta rate. We caution however, that in practice it is doubtful that a reliable estimate of the magnitude of the adjustment can be obtained. Furthermore, in our opinion it is not clear that an adjustment is required.

Increasing the allowed return by increasing beta is not an obvious choice based on the theory of the Black CAPM. It is, however, an option to exercise regulatory judgement and increase the allowed return through the device of adjusting beta. However the link to the Black CAPM models is tenuous and the adjustment is subjective not objective. Thus the adjustment is open to the criticism that it is not transparent. The adjustment to beta does, however, provide a way to continue using the SLCAPM, which has the benefit of retaining the model that is extensively used in practice. In contrast, we see no evidence that the Black CAPM is used in practice and in this report we argue against its use in determining regulated returns.

The utility of DBP's approach to estimating the return on equity using empirical results from the Black CAPM, 'transformed' into the Sharpe Lintner framework;

We are unconvinced by the beta adjustment adopted by DBP which extends the ERA beta adjustment. First it is not clear that an adjustment is necessary and second if an adjustment is necessary, the natural choice is to adjust the intercept (risk free rate) rather than the slope (beta). Furthermore, if the empirical estimate of the intercept in tests of the SL CAPM is positive[9] it does not automatically follow that the risk free rate must be adjusted upwards. If an adjustment is considered necessary, we make a case for a downward adjustment to returns. We have also noted earlier that DBP's approach effectively replaces the SL CAPM calculation with the Black CAPM calculation, which we consider to be entirely inappropriate.

The 'problem' thrown up by many SL CAPM tests is that they have a positive intercept. The financial industry tends to regard this as 'smart beta' i.e. low risk stocks outperform high risk stocks; this outperformance is often understood in behavioural terms. In this context, if an adjustment is necessary, it would be to subtract the intercept rather than adjust beta. This merits some explanation as it contrasts with the usual claim for a need to adjust the risk free rate upwards, as in the usual arguments for adopting the Black CAPM.

This usual argument for the Black CAPM is based on the premise that actual returns are equal to equilibrium returns on average and thus a positive intercept in tests of the SL CAPM are assumed to be driven by the SL CAPM underestimating (overestimating) realised returns for low (high) beta stocks. An alternative premise is that the results are a consequence of actual returns outperforming (underperforming) equilibrium returns for low (high) beta stocks. In the parlance of funds management such outperformance is expressed as alpha. Thus low beta stocks have positive alphas. In this case an estimate of the equilibrium return is obtained by subtracting alpha from the actual return. Whether the resulting return is then higher or lower than the regulated return is an open question and will depend upon the magnitude of alpha and beta.

The underlying statistical theory in testing of the CAPM is dependent on the approach the regulated, or the regulators, choose to use in their empirical work. Applying Occam's Razor, the

[9] As explained shortly tests of the SL CAPM hypothesise a zero intercept.

simplest and most consistent theory seems to be time-series modelling of SL CAPM without assuming constraints. As we detail in the discussion of the intercept below, the validity of the SL CAPM can be tested by looking at the intercept in such models. Following the discussion of the intercept term, we show that even when the SL CAPM theory is true a negative correlation between intercepts and slopes is to be expected in time series regressions. This has nothing to do with bias in betas. Thus, if any adjustment needs to be made it should be an intercept adjustment, not an adjustment to beta

The intercept term

Here we consider the intercept terms in the SLCAPM and the Black CAPM.

Consider the data-generating process:

$R_{it} = \alpha_i + \beta_i R_{mt} + V_{it}$ (1)

and

$R_{it} = r_{it} - r_{ft}$

where R_{it} is the excess rate of return on the portfolio of interest whilst R_{mt} is the excess rate of return on the ''market'' portfolio. V_{it} is some random noise and we initially assume that $V_{it} \underbrace{iid} N(0, \sigma_i^2)$. The variable, r_{it} ,is defined as the rate of return on asset i in period t and r_{ft} is defined as the riskless rate of return in period t. Equation (1) is referred to as the Sharpe Market Model (see Sharpe 1963) and implications from it are discussed in Fama and French (2004; p.29, 32)

We note that the risk premium of any asset *i* is defined by the expectation of R_{it} so $E(R_{it}) = RP_i = \mu_i - r_f$ for unconditional expectations. If we took conditional expectations $E_t(R_{it+1}) = RP_{it}$

Considering for the moment, equation (1), we can take (unconditional) expectations to derive

$\mu_i - r_f = \alpha_i + \beta_i(\mu_{m-}r_f)$ $\mathbf{(2)}$

Where $\mu_i = E(r_{it})$, $\mu_m = E(r_{mt})$ and r_f the riskless rate of interest is assumed constant for ease of exposition.

The SL CAPM implies that $\alpha_i = 0$ $\mathbf{(3)}$

The Black CAPM assumes (unconditionally) that there is a parameter γ_0 (interpreted as the expected rate of return of the zero-beta portfolio in the Black CAPM) such that

$$\mu_i - \gamma_0 = \beta_i(\mu_m - \gamma_0) \quad \mathbf{(4)}$$

Equation (2) can be written so that $\alpha_i = (1-\beta_i)(\gamma_0 - r_f)$ and so $\gamma_0 = r_f + \frac{\alpha_i}{1-\beta_i}$

The term $\frac{\alpha_i}{1-\beta_i}$ is the zero-beta premium.

We note that a positive intercept in tests of the SL CAPM does not automatically imply that the Black CAPM applies. Thus positive intercepts are not automatically estimates of the zero beta premium.

Negative correlation between the intercept and beta

A considerable part of the submissions and reports that we are discussing are concerned with so called low beta bias. This is key to the submissions' arguments for using the Black CAPM, as it is purported to correct this supposed bias. We address this issue in the general context of linear regression.

For a linear regression, if we have $y = X\theta + V$ where y is $(n \text{ x } 1)$, X is $(n \text{ x } k)$, θ is $(k \text{ x } 1)$ and $V(n \text{ x } 1)$ where $V \sim (0,\ \sigma^2 I_n)$. The above notation means that the estimators are distributed with mean vector 0 and covariance matrix $\sigma^2 I_n$ where I_n is an n by n diagonal matrix with one's down the diagonal.

Under classical assumptions, it is well-known that

$$\hat{\theta} \sim (\theta, \sigma^2\ (X'X)^{-1})$$

In particular, if $X = \begin{pmatrix} 1 & X_1 \\ 1 & X_n \end{pmatrix}$ $\theta = (\begin{smallmatrix} \alpha \\ \beta \end{smallmatrix})$

$$\hat{\theta} \sim ((\begin{smallmatrix} \alpha \\ \beta \end{smallmatrix}), (\begin{smallmatrix} \sum X_{i,}^2 & -n\bar{X} \\ -n\bar{X}, & n \end{smallmatrix}) \frac{1}{\sum (X_i - \bar{X})^2} \quad \text{where } \bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

This tells us that $cov(\hat{\alpha}, \hat{\beta}) = \frac{-n\bar{X}}{\sum (X_i - \bar{X})^2}$.

In the context of the Sharpe Index Model, we note that $\bar{X} = \frac{\sum_{i=1}^n (R_i)}{n}$; that is, it is the mean excess return and so we find that $\hat{\alpha}$ and $\hat{\beta}$ are negatively correlated if excess returns are positive on average in the sample. We would expect the latter condition to hold on average, although there may be periods when it does not hold.

If the SLCAPM holds we know from (3) that $\alpha = 0$. However, from the foregoing analysis, firms with high estimated betas would be expected to have low (negative) estimated alphas and stocks with low estimated betas should have high (positive) estimated alphas. This will happen in time-series regression when the SLCAPM holds and when the true model is Sharpe's Market Model. This has absolutely nothing to do with a beta bias of any kind.

A popular approach to testing asset pricing models is based on a different procedure to the foregoing analysis. Much of the published work has been done on the basis of two-pass methods that first involve historical estimates of beta, then involve cross-sectional regressions based on estimating the market-risk premium as the slope coefficient. These methods are prone to a large number of statistical problems. As an example, see the discussion in Black, Jensen & Scholes 1972. Taking this as a highly regarded and well cited example, they deal with issues involving endogeneity of right hand side variables in the second stage of their two stage regression plus the possibility that errors are correlated in the second stage. The solutions they offer involve the grouping of variables and the use of instrumental variables, all of which are statistically correct, but which have quite complex finite sample properties so that one needs to rely upon asymptotic theory to understand the properties of the estimators. There is some choice in these methods and the appropriate tests and interpretation of the results of asset pricing model tests is still the subject of debate, as we discuss in the section on model adequacy tests. Since the outcomes of such tests depend on what you choose to do, it seems to us, that such procedures are not appropriate for regulatory pricing.

Industry portfolios or beta sorts?

In tests of asset pricing models it is common to use portfolios, where the portfolios are formed by sorting stocks on some criteria such as company size. Results of asset pricing tests may differ according to the criteria used for sorting portfolios. In the current context it is appropriate to ask: What portfolios should we be considering? From a regulatory perspective, we want to estimate the return for the industry that is being regulated. It is therefore logical that it is industry portfolio returns that matter, rather than portfolios constructed by sorting on past estimates of beta. It is thus a shame that much of the focus of DBP (2016) is on the 10 beta-sorted portfolios rather than the 26 industry portfolios, as whatever evidence may have been gleaned from study of the former seems much less relevant than evidence from the latter. It would have been desirable to have seen some more detailed research on the industry portfolios, even allowing for deficiencies in the data such as survivorship bias. As we discuss below the results reported for the industry portfolios do not lead to rejection of the SL CAPM.

Strategic Information Consultants

We are very impressed by the Strategic Information Consultants (2016) paper written by Dr John Henstridge and co-authors. Indeed we would regard it as an essential read for any consultant venturing into this area. We strongly endorse the comments that measurements such as beta estimates are model-dependent and not invariant to the specification of the model, see paragraph 42b and 42c.

Unfortunately their work focuses on the ten portfolios constructed by sorting on past betas. However, the case of real interest in the regulatory framework is not the ten beta sorted portfolios, but the industry portfolios case as discussed above. We would be interested to see what the conclusions of Strategic Information Consultants would be for the analysis of the industry portfolios.

The utility of DBP's empirical 'model adequacy test

We have discussed the model adequacy test in general terms above. Here our analysis is of the specific model adequacy tests as detailed in DBP (2015) which provides detailed background on the model adequacy tests. The approach taken in DBP (2015) is to use a 500 stock universe based on the top 500 stocks by capitalisation on the ASX and use a value weighted portfolio of these stocks as the proxy for the market portfolio. The tests are based on the SPPR database from SIRCA and utilise ASX return data from 1969 to 2013. Tests are conducted on the returns of ten portfolios sorted by estimates of beta and on 26 industry portfolios with returns supplied by SIRCA. The risk-free rate used is the 10 year government bond yield observed on a monthly basis.

In equation 7 and onwards, DBP (2015) utilise what is known as the conditional CAPM. In simple terms, this is a CAPM relationship based on information available at time t-1 about expected returns in time t. Conditional versions of the SLCAPM and the Black CAPM are described in equations 7 and 8 of DBP (2015).

Empirical estimates of required returns (expected returns in equilibrium) utilising the SL CAPM and the Black CAPM are then compared with actual returns. This comparison is used as a test of bias when utilising the required returns as forecasts of actual returns. DBP (2015) present two methods A and B, which compute the bias of forecasts based on time varying betas for both versions of the CAPM. The two methods differ in that method A utilises the ex-ante estimate of the market risk premium as determined by the regulator. Method B sets the time varying excess return on the market equal to its actual value. This latter approach assumes perfect foresight in forecasting market returns. We are not entirely clear why method B is adopted, but it appears that method B tends to reject the hypothesis of a zero average error more frequently than method A.

DBP motivate method B on the assumption that unbiased forecasts are rational and so rational regulators should use unbiased forecasts. However, it is not clear that the regulator’s utility should solely be a function of unbiasedness and ignore other desirable properties of forecast returns. See Kendall’s (1959) “Hiawatha designs an experiment” for an object and entertaining lesson about the problem of focussing solely on unbiasedness. It is also the case that unbiasedness does not mean perfect foresight.

As a test of expected returns in equilibrium, Method B suffers from the use of ex-post information. Whereas tests of asset pricing models are generally careful to only use information observed ex-ante. Method B assumes perfect foresight with respect to the realised excess return on the market. If investors could correctly forecast time varying excess returns on the market, then their behaviour would have been different. They would, for example, have avoided equity when the excess returns were forecast to be negative. In short equilibrium prices and hence actual returns would have been quite different from those actually observed.

The detailed calculations of the power of the tests presented in DBP (2015) are of some scholarly interest. However, the difficulty with all power calculations is that they will depend upon the alternative hypothesis. In this case the alternative is that the Black CAPM holds, that the SL CAPM is false and the zero-beta premium is 50 basis points a month. Whether this is the appropriate amount is an open question. It is certainly the case that the power calculations are based on numbers different from those that are detailed in recent regulatory submissions, where it is not uncommon to claim that zero-beta premium is larger than 50 basis points per month, for example HoustonKemp (2016a). As we argue elsewhere in this report if the zero-beta premium exists a generous estimate is 16 basis points a month, so that the power calculations are likely to favour the Black CAPM by picking points under the alternative hypothesis that are a long way from the null hypothesis.

Tables 7 and 8 from DBP (2016) are reproduced below and provide statistics for the mean forecast error for the SL CAPM by industry. The description in DBP's text says that the results of the ERA's version of the SL CAPM are in Table 8, whereas according to the title on Table 7 it gives the ERA's version of the SL CAPM. We think the latter is correct, but fortunately, the labelling is of no real consequence as there is relatively little difference in the nature of the results between the two tables.

The results in Tables 7 and 8 generally are supportive of the SL CAPM. Across the 104 tests in the two tables significant bias is only observed with respect to 3 industries. These are retailing, pharmaceuticals and utilities, which provide six results significant at the 5% level. With the exception of retailing, these results are only significant for Method B. In short there is very little evidence of significant bias and the number of significant results is approximately the number expected by chance. With a type 1 error of 5% we would expect 5.2 of the 104 hypotheses to be rejected even if the null is true. Thus finding only 6 rejections suggests to us that the SL CAPM is supported by these testing procedures.

The results above are buttressed by Da, Guo and Jagannathan (2008) who in an unpublished version of a subsequently published paper (2012) show the same result for US portfolios. They examine the performance of the SL CAPM on the 10 Fama and French (1997) industry portfolios. They find that cross-sectionally the SL CAPM explains approximately 50% of the average returns on the 10 industry portfolios. The inclusion of two additional factors - SMB and HML (SMB in particular) -improves the adjusted R-square to be more than 83%. However, such higher R-square is accompanied by negative risk premia for the additional factors. When they use time-series regressions, they find that during 1932-2007, the SL CAPM explains return variation slightly better than Fama-French three-factor model does. Thus the evidence for the viability of the SL CAPM as an appropriate model for time series regressions is supported, at the industry level, not just by the Australian results above, but also by results for the USA.

Table 1: Table 7 reproduced from DBP (2015)

Table 7

ERA's version of the SL-CAPM

Wald statistic		Method A		Method B	
		22.900		29.621	
	Beta	Mean forecast error	t-test	Mean forecast error	t-test
Energy	1.595	0.168	0.444	0.042	0.146
Materials	1.014	0.126	0.472	0.020	0.142
Metals & mining	1.365	0.264	0.763	0.127	0.668
Capital goods	0.920	0.085	0.288	-0.007	-0.039
Commercial services	0.992	-0.136	-0.468	-0.216	-1.028
Transportation	0.523	0.109	0.351	0.053	0.187
Automobiles	0.669	0.069	0.174	-0.002	-0.007
Consumer durables	0.734	0.650	1.560	0.541	1.478
Consumer services	0.901	-0.039	-0.137	-0.239	-1.123
Media	1.235	-0.362	-0.788	-0.479	-1.271
Retailing	0.472	-0.573	-1.854	-0.654	-2.472
Food retailing	0.840	-0.175	-0.750	-0.254	-1.483
Food, beverage & tobacco	0.963	-0.189	-0.674	-0.279	-1.211
Health care	0.958	-0.040	-0.141	-0.128	-0.590
Pharmaceuticals	0.662	-0.599	-1.766	-0.660	-2.155
Banks	1.082	-0.232	-0.852	-0.295	-1.356
Diversified financials	0.868	-0.118	-0.465	-0.203	-1.238
Insurance	1.031	-0.338	-0.899	-0.451	-1.515
Real estate (excluding REITs)	1.339	0.080	0.240	-0.022	-0.096
REITs	0.503	0.026	0.133	-0.015	-0.096
Software & services	1.046	0.455	0.836	0.311	0.640
Technology hardware	0.847	0.349	0.603	0.151	0.287
Telecommunication services	1.932	0.105	0.179	-0.040	-0.075
Utilities	0.865	-0.435	-1.272	-0.557	-1.958
GICS code unassigned	1.364	0.163	0.435	0.008	0.032
GICS code unknown	0.882	0.022	0.050	-0.039	-0.119

Note: The tests use SIRCA data from January 1974 to December 2013.

Table 2: Table 8 reproduced from DBP (2015)

Table 8

Vanilla SL-CAPM

		Method A		Method B	
Wald statistic		24.278		44.276	
	Beta	Mean forecast error	t-test	Mean forecast error	t-test
Energy	1.436	0.083	0.218	-0.043	-0.158
Materials	0.959	0.096	0.361	-0.006	-0.045
Metals & mining	1.295	0.226	0.653	0.091	0.484
Capital goods	0.857	0.051	0.172	-0.036	-0.195
Commercial services	0.909	-0.181	-0.622	-0.257	-1.236
Transportation	0.380	0.032	0.102	-0.020	-0.070
Automobiles	0.518	-0.012	-0.031	-0.074	-0.204
Consumer durables	0.584	0.569	1.366	0.482	1.296
Consumer services	0.721	-0.135	-0.482	-0.289	-1.346
Media	1.067	-0.452	-0.985	-0.553	-1.458
Retailing	0.347	-0.641	-2.071	-0.715	-2.598
Food retailing	0.772	-0.212	-0.908	-0.286	-1.696
Food, beverage & tobacco	0.866	-0.242	-0.860	-0.321	-1.417
Health care	0.866	-0.090	-0.318	-0.174	-0.813
Pharmaceuticals	0.523	-0.674	-1.988	-0.731	-2.378
Banks	0.984	-0.285	-1.045	-0.342	-1.642
Diversified financials	0.802	-0.154	-0.606	-0.234	-1.426
Insurance	0.863	-0.429	-1.140	-0.539	-1.793
Real estate (excluding REITs)	1.235	0.024	0.072	-0.075	-0.339
REITs	0.440	-0.008	-0.043	-0.047	-0.297
Software & services	0.817	0.331	0.609	0.205	0.417
Technology hardware	0.608	0.222	0.382	0.086	0.161
Telecommunication services	1.565	-0.093	-0.160	-0.242	-0.466
Utilities	0.736	-0.504	-1.475	-0.615	-2.139
GICS code unassigned	1.260	0.106	0.284	-0.042	-0.160
GICS code unknown	0.841	-0.000	-0.001	-0.059	-0.183

Note: The tests use SIRCA data from January 1974 to December 2013.

DBP (2015) concludes by considering the question of whether to estimate betas using daily or weekly data. They simulate betas on the basis that excess returns satisfy the relation given in their equation 29, reproduced below as Exhibit 2:

Exhibit 2: Equation 29 reproduced from DBP (2015)

$$z_{jt} = \beta_j z_{mt} + \varepsilon_{jt}, \qquad \beta_j = 1, \qquad \begin{pmatrix} z_{mt} \\ \varepsilon_{jt} \end{pmatrix} \sim \mathrm{N}\left(\begin{pmatrix} 0.0002 \\ 0.0000 \end{pmatrix}, \begin{pmatrix} 0.01^2 & 0 \\ 0 & 0.01^2 \end{pmatrix} \right), \tag{29}$$

The results of the simulation are given in DBP (2015)'s Table 10, which is reproduced below.

Table 3: Table 10 reproduced from DBP (2015)

Table 10

Simulation results

	Weekly data						
	Monday-to-Monday	Tues-to-Tues	Wed-to-Wed	Thurs-to-Thurs	Friday-to-Friday	Average	Daily data
Mean	1.000	1.000	1.000	1.000	1.001	1.000	1.000
Std Dev	0.062	0.063	0.062	0.062	0.061	0.051	0.028

Notes: The simulations are based on 10,000 replications each of which uses ordinary least squares and five years of data to estimate the beta of the stock.

We consider that Table 10 is an especially weak piece of analysis. We note that under the assumptions of the model in equation 29:

$$\hat{\beta}_j \ \ is \ N(\beta_j, \frac{\sigma^2}{\sum_{i=1}^{N} X_i^2})$$

For the values used in the simulation: $\hat{\beta}_j \ \ is \ N(1, \frac{1}{N})$

Readers can confirm that all the values in the table can be deduced from this formula setting N equal to 250 or 1250 and using the fact that the weekly average is based on the average of 5 daily calculations. One wonders why the simulation was necessary. The issues as to the relative magnitudes of daily versus weekly versus monthly standard errors are much more complex than just assuming independently and identically distributed (iid) returns. The daily returns typically exhibit some sort of autocorrelation, which is low but nevertheless matters when we come to calculate annualised standard errors.

Responding to the criticisms of Partington and Satchell set out by DBP and its consultants Competition Economist Group and HoustonKemp.

We now consider the criticism of the results of Partington and Satchell as presented in DBP (2016) section 6.67, which is largely based on HoustonKemp (2016). We find no convincing arguments presented in DBP to suggest that our basic position is incorrect and in this report we present a great deal more evidence, which suggests that most of the empirical calculations can easily result in implausible numbers and do.

We observe that the ERA has correctly interpreted our prior advice to the AER as being supportive of the ERA's view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust. Table 24 of ERA (2015) shows that the Australian estimates of the annual zero beta premium vary considerably from 0.99% to 8.19% and as we show below NERA (2013) provides an even higher estimate of 17.68%. Thus both our theoretical analysis and the empirical data point to considerable variation in the estimates of the zero beta premium. This reflects inherent problems in the estimation of the zero beta premium and sensitivity of the estimates to choices made in the method of analysis, which renders the estimates open to gaming.

We further point out that it is well understood that if the proxy for the market portfolio is not an efficient portfolio then there is an infinite set of possible zero beta portfolios and hence an infinite set of zero beta premiums that could be selected. The likely retort is that the use of regression constrains the choice, but then the result depends on the data included in the regression, for example the nature of portfolio sorts and the stocks chosen for analysis. A result amply demonstrated by comparing the SFG estimate of a 3.4% premium to the much higher premiums, typically in excess of 8% , provided by NERA and HoustonKemp. The difference between these estimates being explained by the different portfolio sorts that were used.

There is also another problem in estimating the zero beta premium and that is that the proxy for the market portfolio inevitably changes through time. Consequently its location in mean variance/standard deviation space changes. It is well known that the location of the zero beta portfolio is sensitive, sometimes very sensitive, to the precise location of the proxy for the market portfolio. This is a problem for empirical estimation, which usually spans a decade or two.

Stability of the zero beta premium (6.67a)

The first point DBP make (6.67a) is that the zero-beta estimates as presented by NERA and HoustonKemp are stable through time. We note that these estimates are calculated recursively and that they do not represent independent samples. We could conceive that if we had 100 data points and a rolling window of 60 data points, then the actual number of independent measurements of the zero-beta estimate is much less than 100, and the resulting estimators will be stable through time by construction.

As an example of variation in portfolio estimates of the zero beta premium using non-overlapping periods, we reproduce below NERA's (2013) Table 5.3. It is immediately evident that depending on the period used for estimation there is substantial variation in the estimated zero beta premium. It is also evident from the standard errors that the estimates are very imprecise. In the case of the zero beta premium of 17.8% for portfolios estimated from 1974 to 1993, the estimate is not significantly different from zero at the 5% level and has a 95% confidence interval of plus or minus approximately 19%. The portfolio estimate for 1994 to 2012 of 10.03% has a 95% confidence interval of plus or minus approximately 9%. While the table shows no significant difference between these two estimates of the zero beta premium this is somewhat misleading. The zero beta premiums are very imprecisely estimated, resulting in such wide confidence intervals it is no surprise that they overlap. Statistical testing in this case has very low power to detect significant differences.

Table 4: Table 5.3 Reproduced from NERA (2013)

Table 5.3
Stability tests that use estimates of the zero-beta premium

	Portfolios			Securities		
	1974-1993	1994-2012	Difference	1974-1993	1994-2012	Difference
Estimate	17.68	10.03	7.65	12.99	9.00	4.00
Std. error	(9.78)	(4.70)	(10.85)	(5.31)	(4.25)	(6.80)
P-value	[0.09]	[0.05]	[0.49]	[0.02]	[0.05]	[0.56]

Government bond rate or zero beta premium (6.67b)

Partington and Satchell make the point that the government bond rate does not have to be estimated as it is directly observable and has the advantage of being current. The zero beta premium in contrast has to be estimated, with all the attendant problems of that estimation and because decades of data are used in estimation of the zero beta premium it is not current. DBP respond by suggesting that by adding the estimated zero beta premium to the current risk free rate the result is a current zero beta rate. This is simply wrong. As an analogy consider computing an average premium of government bonds over Treasury notes for say the last 20 years. Then taking this premium and adding it to the current Treasury note yield and calling the result the current yield on government bonds, it would be ridiculous.

HoustonKemp rely, rather curiously, on the argument that if we add a zero-beta premium to the current risk free rate, we get a current zero-beta rate and, somehow, mysteriously, this zero-beta rate is endowed with attractive stable properties from the attractive stable properties of the risk free rate. A little reflection, however, reveals that this is fallacious. If we add a variable with an infinite mean to a variable with a finite mean, the resulting variable will have an infinite mean. We provide a proof as follows:

Suppose that the mean of X, $\int x\, pdf(x)\, dx$ is infinite. Suppose that the mean of Y, $\int y\, pdf(y)\, dx$ is finite where $pdf(x)$ is the probability density of X. The term $pdf(x, y)$ is the joint probability density of $X\ and\ Y$. Using well-known properties of random variables, the mean of $x + y$ is:

$$\iint (x + y)\ pdf(x, y)\, dxdy$$

$$= \iint x\, pdf\,(x, y)\, dxdy + \iint y\, pdf\,(x, y)\, dxdy$$

$$= \int xpdf\,(x)\, dx + \int ypdf\,(y)\, dy$$

Which is the sum of an infinite quantity and a finite quantity, which is infinite.

Problems in estimating the zero beta premium (6.67c)

Both from our own analysis and the work of Beaulieu, Dufour and Khalaf (2012) we conlude that the estimation of the zero beta return and zero beta premium is unreliable. We quoted Beaulieu, Dufour and Khalaf as follows:

"Identification: as βi→1, γ becomes weakly identified. Weak identification (WI) strongly affects the distributions of estimators and test statistics, leading to unreliable inference even asymptotically. This should not be taken lightly: reported betas are often close to one (see e.g. Fama and MacBeth, 1973). ***Further, even if estimated betas are not close to one, irregularities associated with WI are not at all precluded [in view of (1) and (2) above]****."* Beaulieu, Dufour and Khalaf (2012. P.3, emphasis added)

The DBP/HoustonKemp response is that betas close to one are not an issue in their sample. As the quote shows beta being close to one is a sufficient condition for problems of estimation and inference, but it is not a necessary condition. Even if betas are not close to one problems in estimation and inference are not precluded. In any event, it would be very surprising if the top 500 stocks on the ASX all had betas distant from one. Also HoustonKemp (2016a, p14) report "…at each point in time the Black model looks back at past data, sees little relation between mean return and beta and so sets the betas of the 10 portfolios close to one."

Even if some of the betas are a long way from 1, we only need some of them to be close to one for the problem to remain. The precise details of why this is so requires a great deal of mathematics and is not appropriate for this report, but we allude in the appendix as to why zero-beta estimates typically do not have finite means. Intuitively this means that inaccurate estimates are very possible. Under normality it is likely that, as the number of assets are increased, the less the chance that the mean will grow explosively. Under other distributions, however, we cannot rule out the possibility that we still get exploding expected values of estimators. However, the practical consequence of this seeming improvement in reliability of the mean is that the investigator can choose his sample of assets and tinker with it until he gets the answer he wants; this is unsatisfactory for regulatory calculation.

DBP/HoustonKemp also reverse the argument analysed above (6.7b), arguing that it is instability in the zero beta rate that is identified by Beaulieu, Dufour and Khalaf (2012) and that this does not apply to the zero beta premium. Implicitly the argument is that subtracting the risk free rate from the zero beta rate fixes the instability. This argument is as dubious as the argument in section 6.7b that adding the risk free rate to the zero beta return results in a stable estimate.

Simulation and critical values (6.67d)

We agree with DBP that the correct approach is to simulate if there is an issue about the critical values of a test and their approach has some merit. However, whenever you simulate, you need a true model and the assumptions you make need to be carefully explained as they may not be deemed appropriate in a particular context. It would have been helpful if DBP had cross-referenced to provide the information without having us wade through the hundreds of pages of documentation.

Da, Guo and Jagannathan (2012) (section 6.67e)

The Da Guo and Jaganathan (2012) paper goes to the question of the continuing use of the SLCAPM in practice and why evidence from equity returns should not necessarily be considered as evidence against the CAPM in determining the required return for projects. However, we agree with DBP that the growth option approach of Da, Guo and Jagannathan (2012) differs from the application of the SL CAPM as used by regulators and the complexities probably make it inappropriate for regulation. We are firmly of the view that regulatory calculations should not be gameable, which is one of the many reasons why we reject the zero-beta CAPM. The inappropriateness of the Black CAPM is rather well exemplified in para 6.61, submission of DBP (2016) ‘‘some versions of the Black CAPM with different estimation methods for the zero-beta premium may have passed as our implementation does and some may have failed’’.

Kan, Robotti and Shanken (2013) (6.67f)

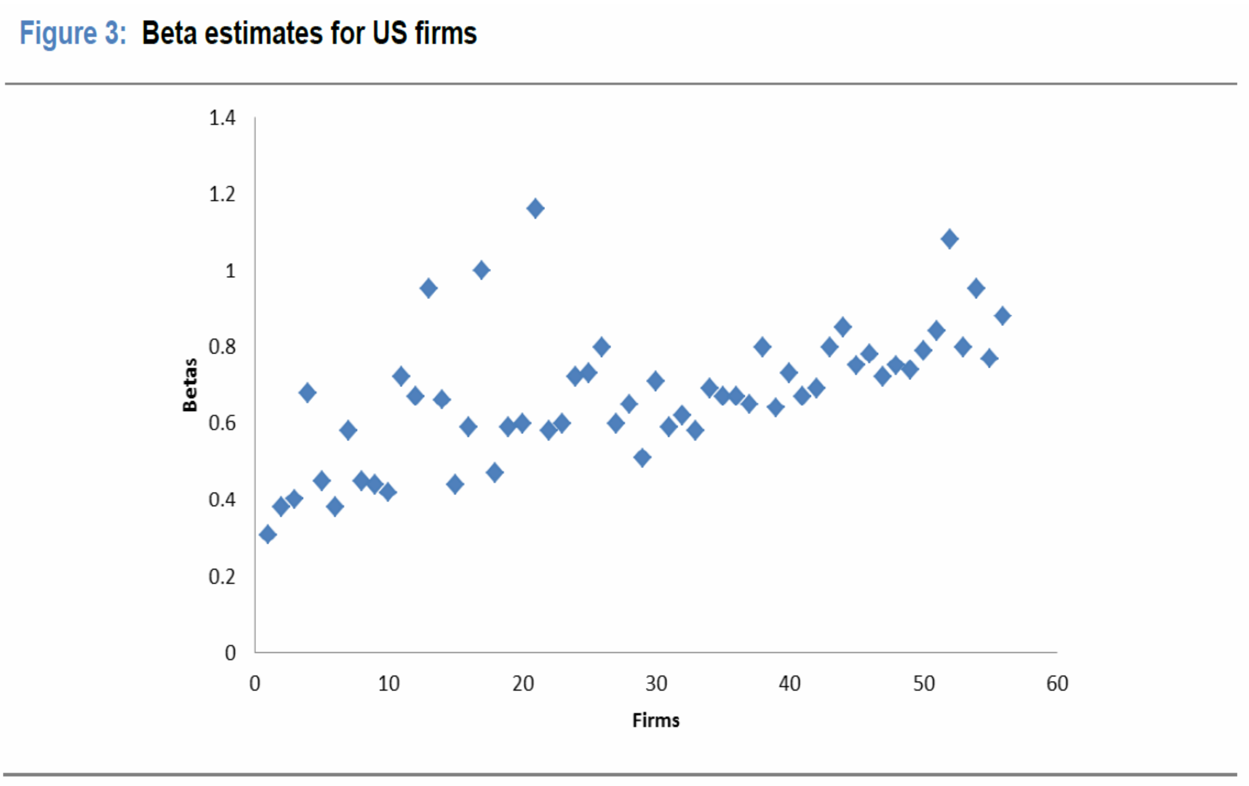
We have argued that the results Kan, Robotti and Shanken (2013) show that the results of the asset pricing tests depend upon the characteristics used in sorting stocks into portfolios. It is therefore pleasing to see that DBP acknowledges that there is a reversal of ranking of the Fama French model and the CAPM when the method of portfolio formation changes. However, as we have previously stated in Partington and Satchell (2015) the SL CAPM does not fare particularly well in the Kan, Robotti and Shanken tests although the IC CAPM (inter temporal CAPM) is a clear winner. The results of Kan, Robotti and Shanken show the difficulty of all attempts to fit asset pricing models to realised returns, including the work of NERA/HoustonKemp.

Beta Estimates (6.71 – 6.73)

DBP (2016), 6.71 – 6.73, take issue with the ERA’s contention that the betas for an energy firm should be less than one and with McKenzie and Partington’s argument that energy firms have low systematic risk because they are insulated from business risk since they face inelastic demand. As a rebuttal of these arguments DBP presents Figure 3, reproduced below, which contains beta estimates for US energy firms.

Rather than rebutting the arguments of the ERA and McKenzie and Partington, the figure supports them. There are only three data points, that is less than 5% of the observations, with a beta of one or above, and the overwhelming majority of observations, approximately 86%, have betas less than or equal to 0.8.

Figure 1: Figure 3 reproduced from DBP (2016)



Criticism of the use of the Black CAPM in regulation

There are some high level criticisms of the Black CAPM for use in regulation which the ERA should be aware of.

1.) Despite this model having a place of prominence in Finance Theory, as discussed earlier despite our extensive experience and research we have seen no evidence that the Black CAPM is used by quantitative finance professionals, or corporates, or expert valuers.

2.) The Black CAPM can be estimated in many different ways and can provide many substantially different results. This fact, in our view, makes it most inappropriate for regulatory use as gaming will be possible.

3.) Estimated versions of the zero-beta premium can have infinite means in a number of different cases that we have analysed (see appendix 1). Furthermore if the portfolio used as a proxy for the market portfolio is inefficient there are an infinite set of zero beta portfolios to choose from. This is of concern as it renders the estimates unreliable and potentially highly variable.

4.) Whilst DBP claim to put a great deal of emphasis on theoretical justification (see for example DBP (2016) paragraph 2.23 -2.26 and ERA (2015) paragraph 23 – 26) it seems that the theory is only adhered to on a selective basis, in particular, if we follow the theory of Brennan (1971), it must be the case that ZBP must be less than or equal to the spread between the borrowing and lending rate, presumably at 10 years. The mean spread between 10 year bonds and A rated corporate bonds over the period from the January 2005 to March 2006 was about 16 basis points per month. This is a generous estimate of the limits imposed by the Brennan model as A rated corporate bonds are neither risk free, nor even the highest rated corporate bonds. Furthermore, the estimate was made over a period when credit spreads were much higher than normal. In contrast the DBP estimates of the zero beta premium are more than four times as big. Of interest is the large variation between the DBP estimates versus the much lower estimates from ERA and SFG. This fact alone illustrates the substantial difficulties in getting an unambiguous and reliable estimate of the zero beta return.

5.) A second theoretical feature of the zero-beta portfolio is that it must lie below the global minimum variance portfolio if the market lies above the global minimum variance portfolio. This again provides a constraint on what the zero beta premium can be. Furthermore, since in this case the zero beta portfolio is necessarily mean variance inefficient, no sensible investment decisions should be based upon it. It is virtually a truism for professional investors that factors employed in risk/return models should be investable.

6.) There is the belief that zero-beta CAPM somehow corrects a bias in the SL CAPM. We note that the ERA admit a bias (paragraph 141 of their guidelines). We disagree with both parties that the evidence for a bias is compelling. Nothing in the statistics of the time-series version of the SL CAPM suggests that beta should be reduced and alpha should be increased. In fact, if there are any implications from this model, we should reduce the intercept and keep the beta fixed.

DBP's contention that the model adequacy test overcomes the problems associated with the robustness of the Black CAPM approach

The Model Adequacy Test DBP (2016) use is a standard one. In the case of a single variable the test is the Mincer-Zarnowitz test and in the case of multiple assets there is a Wald test version of it. The procedure is based on the mean square error which is the variance of the forecast error plus the bias squared. This approach could be deemed appropriate if the loss function of the beneficiary, presumably the Australian public, or the regulatory authority protecting the public, was a mean square (quadratic) loss function. The test purports to test unbiasedness and we mention three caveats that apply here.

An unbiased forecast may not always exist. As an example, consider the auto-regressive model of order 1 (AR(1)) case.

If $y_t = \alpha y_{t-1} + V_t$, our forecast is $\hat{\alpha}_t y_t$ = y_{t+1}^t

where $\hat{\alpha}_t$ is based on data up to time t.

The forecast error is $e_{t+1} = y_{t+1} - y_{t+1}^t = (\alpha - \hat{\alpha}_t)\, y_t + V_{t+1}$

$E(e_{t+1})$ is not equal to 0.

The point is that unbiasedness does not follow automatically.

There may be a different loss function for the regulator than the quadratic one assumed. There is a large literature on the effect of different loss functions (see for example Patton and Timmermann (2004)) and it is well understood that the Mincer-Zarnowitz test is not an appropriate test of optimal forecasts in these alternative cases. Possibly a more general procedure such as the Diebold Mariano test should be used. This is of relevance as the approach used here implicitly assumes that the loss function is quadratic in the forecast error i.e. a model is deemed as optimal if it minimises$E(e_{t+1}^2)$ where e_{t+1} is the forecast error. This is appropriate where the loss depends symmetrically on the positive and negative forecast errors, but this is often not the case. For example, is the Australian public indifferent between a transfer of wealth to regulated businesses (via higher energy prices or other mechanisms) and a transfer of wealth from regulated businesses to the public? Indifference seems highly unlikely.

It is also possible that the procedure is unbiased, but the forecast is not minimum variance. Thus even though the test is accepted, we cannot assume that the method is optimal even in the case of quadratic loss. Suppose $y_t = \beta x_{t-1} + V_t$ where x_{t-1} is strongly endogenous and suppose β is estimated by some procedure based on data up to time t (i.e.$y_1, \ldots . y_t, x_0, \ldots . x_{t-1}$)

$$y_{t+1}^t = \hat{\beta} x_t$$

$$e_{t+1} = y_{t+1} - y_{t+1}^t = (\beta - \hat{\beta}_t)\, x_t + v_{t+1}$$

The e_{t+1} is unbiased $E(e_{t+1}) = 0$ but the forecast is not necessarily minimum variance as we could use any unbiased estimator of β.

DBP argue that testing for unbiasedness is an important exercise as it is consistent with the NPV=0 criterion. However, the evidence that they use for selection of the Black CAPM is the beta sorted portfolios rather than industry portfolios. Indeed the industry portfolios, when model adequacy testing is applied to them with respect to the SL CAPM also satisfy the NPV=0 criterion. Consequently we find DBP's arguments unconvincing.

Aspects of the ERA's own zero-beta premium estimates (for example, all being greater than zero, or, are incorrectly calculated) do not lend support to rejecting the DBP approach.

The ERA (2015) zero beta premia estimates as presented in Table 24, are 4.32% p.a. and 0.99% p.a. Both are much smaller than the estimate from DBP. The variability is not surprising given our comments on the inconsistency in zero beta premium estimation. To the extent that we attach any meaning to zero beta premium estimates they should be within the spread of risk free borrowing and lending rates. Thus, the ERA estimate of 0.99% is plausible and consistent with Llewelyn, Nagel and Shanken (2010) who argue that the zero beta premium should be less than one or two percent. This adds support to rejecting the DBP approach, which gives an implausible zero beta premium estimate in excess of the market risk premium.

HoustonKemp (2016b) provides some criticism, summarised on page vii – viii of their report, of the ERA's handling of data and computation of returns. Whilst we cannot independently check that these claims are true, they do suggest that errors were made by the ERA and that therefore the estimates could be improved. However, the nature of the errors does not suggest to us that if the corrections were made that the estimated mean zero-beta premium would be substantially larger. Ultimately, however, this is an empirical question.

As we explain elsewhere in this report positive estimates for the intercept are not necessarily evidence in favour of a zero beta premium. Neither do they automatically imply that the regulated return should be increased.

Are the resulting DBP Black CAPM estimates of the return on equity unbiased?

We need to be clear what unbiased means. If it means that the DBP Black CAPM estimates, when subject to a model adequacy test as proposed by DBP are such that the model adequacy test is not rejected, then they are generally unbiased, at least with respect to the beta sorted portfolios. However, this view of unbiasedness then gets translated into a view that the regulator who uses the SL CAPM is providing investors with approximately 4% per annum less compensation. This treats low beta ex-post returns as equilibrium returns. Here and elsewhere in the document we take the view that the low beta anomaly is indeed an anomaly. The correct regulatory return would be more sensibly based on subtracting the intercept term from returns, not adjusting the slope and certainly not treating the Black CAPM (unbiased) returns as fair compensation. The more so since the SL CAPM industry portfolios also pass the unbiasedness test.

Appendix

The purpose of the technical analysis in this appendix is to assess the usefulness of the zero-beta CAPM for determining the cost of capital and hence the regulatory price. The zero beta CAPM has been widely advocated by consultants for energy companies and we shall argue in this paper, that for a number of reasons, it is quite unsuitable.

There is a considerable academic literature relevant to issues of estimation in this context, see for example Gibbons (1982) and later work by Shanken (1986, 1996). These papers address both estimation and testing the constraints implied by the zero-beta CAPM under normality. Later work extends this analysis for non-normal financial data, see for example Beaulieu, Dufour and Khalaf (2005, 2010). However these papers go far beyond the empirical regulatory literature that calculates zero-beta returns and we shall work in a more simplified framework.

Below we present the mean variance (MV) mathematics behind the zero-beta CAPM and prove a result on the non-existence of the estimated mean of the zero-beta portfolio; a critical component in implementing this model.

From MV mathematics if m is an efficient portfolio and z is the zero-beta portfolio, and Ω is the (N x N) covariance matrix, z is defined by the condition $m'\Omega z=0$ (2)

Where for our returns $R_t \overset{iid}{\sim} (\mu, \Omega)$.

$\beta = \mu'\Omega^{-1}i$ where i = (1,….,1)$'$ an N x 1 vector of ones. $\gamma = i'\Omega^{-1}i$ and $\alpha = \mu'\Omega^{-1}\mu$. The term π is the expected rate of return of the mean-variance efficient portfolio used in place of the market portfolio (we call this the proxy portfolio).

It is a standard consequence of MV mathematics that any MV portfolio a can be written as $a = \frac{\gamma\pi-\beta}{\alpha\gamma-\beta^2}\Omega^{-1}\mu + \frac{\alpha-\beta\pi}{\alpha\gamma-\beta^2}\Omega^{-1}i = g(\pi)\Omega^{-1}\mu + h(\pi)\Omega^{-1}i$

As is well-known, we require $\pi > \frac{\beta}{\gamma}$ for the portfolio to be efficient; the quantity $\frac{\beta}{\gamma}$

being the expected rate of return of the global minimum variance(GMV) portfolio.

The condition $a'\Omega$z=0 implies that $\mathrm{g}(\pi)z'\mu + h(\pi)$=0 so that

$$z'\mu = -\frac{h(\pi)}{\mathrm{g}(\pi)}$$

And so z=$\mathrm{g}\left(-\frac{h(\pi)}{\mathrm{g}(\pi)}\right)\Omega^{-1}\mu + h(-\frac{h(\pi)}{\mathrm{g}(\pi)})\Omega^{-1}i$ (1)

describes the minimum variance zero-beta portfolio associated with the portfolio a.

It can be seen from the above that:

$z'\mu = \frac{\beta\pi-\alpha}{\gamma\pi-\beta}$ (2)

The zero-beta portfolio described by (1) has a number of interesting properties; we can derive its variance as well as higher moments. Of immediate interest to us is the result that if portfolio *a* is mean variance efficient then *z* must lie below that of the GMV portfolio. The converse is also true; if *z* is MV efficient then the expected return of the zero beta portfolio must lie below the GMV portfolio; for a proof see Merton (1972).

In the case where a riskless asset exists with rate of return r_f, the corresponding MV efficient portfolio is $\frac{\Omega^{-1}(\mu-r_f\, i)}{\beta-r_f\gamma}$, its zero–beta portfolio can be derived via (2) and this has an expected return r_f.This happens to also be the market portfolio due to two fund money separation, a fact we shall use later.

To see the sets of numbers that are thrown up by equation (2), suppose the “market” is (w,1-w), 0<w<1 and $\Omega = \begin{pmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{pmatrix}$

Let the zero-beta portfolio be (a, 1-a).

If we simplify by setting $\sigma_1 = \sigma_2$,

Condition (2) gives us:

$$a = \frac{-1 + w(1-\rho)}{(2w-1)(1-\rho)}$$

Plausible values for w and ρ might be that w = 0.6, $\rho = 0.4$ but these would give us values of a = -5.3. Thus, in this simple example to "construct" your zero-beta portfolio, you would need, on a A$100m investment, long A$633m in asset 2 and short A$533m in asset 1.

It is clear that such extreme positions might give a mean value that looks plausible but actually "creating" this asset seems ridiculous. Furthermore, in this example, there are only two assets so all portfolios will be MV efficient. Finally, this is not an odd case; we would expect large long and short positions in more realistic cases. Intuitively this arises because the vast amount of assets in head-line indices are positively correlated, see for example, "Life time of correlation between stock prices or established and emerging markets' (Buda 2010). Then if m typically has predominantly positive elements as well, which is what we would expect for a capital-weighted asset, it must be the case that z must have some negative elements to satisfy $m'\Omega z = 0$. Finally whether the zero-beta CAPM leads to a higher or lower cost of capital relative to the market depends upon the relative position of the efficient portfolio relative to the efficient market portfolio (assuming it exists).

It is also worth noting that Merton (1972, footnote 9) mentions. "Although the paper does not impose equilibrium market-clearing conditions, it is misleading as one of the mutual funds is a portfolio that no investor would hold as his optimal portfolio." This, presumably, advises us that the zero-beta CAPM has its limitations as a practical investment tool.

We now define what is known as 'plug-in' estimators.

Let $\bar{R} = \frac{\sum_{t=1}^{T} R_t}{T}$ be the vector sample mean returns.

Let $S = \frac{\sum_{t=1}^{T} (R_t - \bar{R})\,(R_t - \bar{R})'}{T}$ be the sample covariance matrix.

We define 'plug-in' estimators by

$$\hat{\mu} = \bar{R} \text{ and } \widehat{\Omega} = S$$

With the consequence that $\hat{\alpha} = \bar{R}'S^{-1}\bar{R}$, $\hat{\beta} = \bar{R}'S^{-1}i$ and $\hat{\gamma} = i'S^{-1}\, i$ (3)

One method to estimate the mean of the zero-beta portfolio is to substitute (3) into (2).

We now discuss a second method. A simple procedure to estimate γ_0=$z'\mu$ based on time-series regressions is to estimates α_i and θ_i in the regression

$R_{it} - R_{mt} = \alpha_i + \theta_i R_{mt}$+$V_{it}$ (4)

Where, if the zero-beta CAPM holds, and $V_{it}$is iid (0,σ_i^2) then, taking expectations, $\mu_i - \gamma_0 - (\mu_m - \gamma_0) = \alpha_i + \theta_i \mu_m$

Or, $(\beta_i - 1)(\mu_m - \gamma_0) = \alpha_i + \theta_i \mu_m$.

This leads to $(\beta_i - 1)\gamma_0 + \alpha_i$=0 and $\theta_i = (\beta_i - 1)$.

So that we can estimate γ_0 by $\frac{\alpha_i}{(1-\beta_i)}$. If we now have more than one asset we can over-identify γ_0 and use more complex estimators as in Shanken (1986). We refer to the above as method 2.

Yet another specification is used in the situation where a riskless asset exists, but we wish to estimate γ_0; in that situation,

$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft})$+$V_{it}$ (5)

And α_i=$(1 - \beta_i)\gamma_0$; in this interpretation, α_i is interpreted as the excess zero-beta expected return relative to the riskless rate. We refer to this as method 3.

A very important problem with the estimated mean of the zero-beta rate; E(*z'R*) is its non-existence under normality.

Where for our returns $R_t \overset{iid}{\sim} N(\mu, \Omega)$.

Now E(*z'R*) becomes infinite if $\gamma\pi = \beta$ or $\pi = \beta/\gamma$ where it turns out that β/γ is the mean of the minimum variance (MV) portfolio so that it would seem that, as long as $\pi > \beta/\gamma$ the problem will go away. Unfortunately even if $\pi > \beta/\gamma$ it does not mean that estimates$\hat{\gamma}$, $\hat{\pi}$ and $\hat{\beta}$ may not take values such that $\hat{\gamma}\hat{\pi} = \hat{\beta}$ for some realisation. What this says that at times when the proxy portfolio has low returns relative to the MV portfolio is the time when $\widehat{E(z'R)}$ can be very large which may explain some of the very large numbers being provided by consultants.

Theorem 1: For method 1 under normality, the expected rate of return of the estimated zero-beta portfolio is infinite if, using plug-in estimators, $\hat{\gamma}$, ,$\hat{\pi}$ and $\hat{\beta}$, pdf($\hat{\pi}$, $\widehat{\beta}, \hat{\gamma}$) is non-zero on the line $\hat{\gamma}\hat{\pi} = \hat{\beta}$ and the sample Covariance matrix S is non-singular and $\bar{R}$ Is not equal to i.

Proof: We note that for the ratio of estimators to be infinite we need to find a point, or points, where the numerator is non-zero when the denominator is zero and where the pdf is non-zero. Conditioning on S, we note that $\hat{\beta} = \bar{R}'S^{-1}i$ and $\hat{\gamma} = i'S^{-1}i$; $\hat{\pi} = \bar{R}'a$ and we can write the denominator as a conditionally normal variable $i'S^{-1}i\bar{R}'a$ -$\bar{R}'S^{-1}i$ which clearly has positive pdf at $\gamma\pi - \beta$and indeed along the line $\hat{\gamma}\hat{\pi} = \hat{\beta}$.Furthermore along this line, the numerator$\hat{\alpha} - \hat{\beta}\hat{\pi}$ becomes$(\hat{\alpha}\hat{\gamma} - \hat{\beta}^2)/\hat{\gamma}$ which is strictly positive from the positive-definiteness of S and the fact that $\bar{R}$ Is not equal to i.

Theorem 2: For methods 2 and 3 under normality, the expected rate of return of the estimated zero-beta portfolio does not exist.

Proof In both cases $\frac{\alpha_i}{(1-\beta_i)}$ is our formula for γ_0. Using estimates based on the linear regression, both numerators and denominators are normally distributed and it is well known that the ratio of normals has no finite mean.

We next state and prove a result, which, whilst very mathematically obvious, nevertheless, has strong implications for the practical implementation of measuring regulatory capital.

Theorem 3: The cost of capital is identical for any choice of MV efficient portfolio and corresponding zero-beta portfolio.

Proof: Let *a* and *z* be the MV efficient portfolio and corresponding zero-beta portfolio vectors of weights and assume that $a'\mu$ = π. Let *p* be the weights of the corresponding portfolio whose cost of capital needs to be determined. Clearly, the answer is $p'\mu$. To demonstrate that the MV efficient portfolio used is irrelevant, we need to show that $z'\mu + \beta_{pa}(a'\mu - z'\mu)$ is the same for all choices of *a* and *z*.

We note that z is given by (1) and β_{pa} can be calculated in the usual manner as $\frac{p'\Omega a}{a'\Omega a'}$, then it is a tedious calculation using the above and (2) to prove the result. Details are omitted.

Since it does not seem to matter which portfolio we use, subject to MV efficiency, the reasons for choosing a particular one depend upon whether retaining the value of beta because it has a particular significance if calculated with respect to a particular index or because of ease of estimation. It is clear that using a 10 year bond rate together with a high-level equity index seems a way of reducing estimation risk albeit opening up the possibility of mismeasuring the zero-beta portfolio through (wrongly) assuming it as the 10 year rate. This misspecification error can be contrasted with the substantial estimation risk emanating from even the simple versions of zero-beta CAPM.

Theorem 4: Under the Brennan model the market portfolio will consist of a combination of the borrowing and lending portfolios,ω_b and ω_l in some proportion d , 0$\leq d \leq 1$so that market weights are dω_b+(1-d) ω_l

Proof: Since investors will hold either the lending portfolio and long cash long both borrowing and lending portfolios or long borrowing and short, their overall equity position will be in terms of long position in the two Markowitz portfolios.

In principle, if *d* is known, we can compute the expected rate of return in terms of the two Markowitz portfolios and hence determine the zero-beta expected rate of return. If the riskless borrowing and lending rates are r_b and r_l respectively, then the expected returns on the two Markowitz prtfolios can be calculated straightforwardly in terms of $\beta = \mu'\Omega^{-1}i$ where i = $(1,\ldots,1)'$ an N x 1 vector of ones. $\gamma = i'\Omega^{-1}i$ and $\alpha = \mu'\Omega^{-1}\mu$ as well as the two interest rates; we omit details.

Multivariate Extensions for the zero-beta expected rate of return.

We consider the situation where there are *k* assets and we wish to estimate the expected rate of return for the zero-beta portfolio. This is discussed in some detail in Gibbons (1982) and involves a generalisation of the original Black, Jensen & Scholes (BJS) estimator (1972, pp.100-112). This involves a multivariate version of equation 5 either working with excess returns or normal returns.

Suppose $R_t = \alpha + \beta r_{mt} + V_t$ (6)

Where R_t is a $(kx1)$ vector of returns at time t, α and β are $(kx1)$ vectors of parameters and V_t is $iid\ (0, \Sigma)$. Then we have a seemingly unrelated regression system and OLS estimators will be MLE estimators assuming normality.

BJS assume that $\hat{\gamma}_0 = \frac{\hat{\alpha}'(i-\hat{\beta})}{(i-\hat{\beta})'(i-\hat{\beta})}$ whilst Gibbons propose a ''GLS'' version $\tilde{\gamma}_0 = \frac{\hat{\alpha}'\hat{\Sigma}^{-1}(i-\hat{\beta})}{(i-\hat{\beta})'\hat{\Sigma}^{-1}(i-\hat{\beta})}$ where $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\Sigma}$ are the OLS estimators and *i* is a $(kx1)$ vector of ones. Here we might expect the problem to be less severe as essentially the denominator of the BJS statistic is related to a weighted sum of chi-squared ones. Intuitively, the higher the degrees of freedom the more moments should exist and so, at least in principle, increasing the degrees of freedom should lead to more stable estimators.

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Expert Witness Compliance Declaration

We have read "Expert witnesses in proceedings in the Federal Court of Australia" which are attached as Appendix 3. This report has been prepared in accordance with those guidelines. As required by the guidelines, we have made all the inquiries that we believe are desirable and appropriate and no matters of significance that we regard as relevant have, to our knowledge, been withheld from the Court.

Signed

Graham. H. Partington

Steven. E. Satchell

Appendix 1

Terms of reference

Consultancy on the validity of using the Black CAPM for the expected return on equity for a regulated firm

Introduction

The Economic Regulation Authority (**ERA**) is currently assessing a regulatory proposal for a five year access arrangement from Dampier Bunbury Pipeline (**DBP**) – as part of its obligations under Australia's National Gas Law (**NGL**) and National Gas Rules (**NGR**). The access arrangement relates to the Dampier Bunbury Natural Gas Pipeline (**DBNGP**) for the period 2016 to 2020.

An important consideration for the setting of regulated tariffs relates to the rate of return on the regulated asset base. The return on equity is one component of the overall rate of return.

DBP proposed initially that the return on equity be based on the Black Capital Asset Pricing Model (**CAPM**).[10] In support, DBP maintained that the ERA's approach to estimating the return on equity – which is based on the Sharpe Lintner CAPM – is biased, whereas the Black CAPM is not.

To demonstrate this contention, DBP relied on the outputs from a so-called 'model adequacy test', which compares the performance of the Black and Sharpe Lintner CAPMs in estimating the forward looking rate of return, over a following period. In addition, DBP supported its position with a report from the Competition Economists Group on the relevance of various models for estimating the return on equity.[11]

However, DBP's proposal was rejected by the ERA in its draft decision of 22 December 2015.[12] The ERA required that DBP continue to utilise the Sharpe Lintner CAPM for estimating the return on equity, but with an adjustment of the beta estimate to take account of the theoretical insights of the Black CAPM.

The ERA in that draft decision relied extensively upon the insights of Partington and Satchell, in determining that the Black CAPM was not empirically robust in the Australian context, such that the empirical modelling proposed by DBP could not be relied upon.[13] The ERA undertook its own econometric evaluation to demonstrate these insights.

[10] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2015.
[11] Competition Economists Group, *ERA treatment of asset pricing models*, December 2014;
[12] Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020; Appendix 4 Rate of Return*, 22 December 2015.
[13] Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020; Appendix 4 Rate of Return*, 22 December 2015, pp. 43 to 46, pp. 151 to 159, and pp. 217 to 219.

DBP provided its response to the return on equity aspects of the ERA's draft decision on 24 February 2016.[14] For this response, DBP marshalled the support of five consultant reports.[15]

The relevant materials, footnote referenced above, may be found at:

https://www.erawa.com.au/gas/gas-access/dampier-to-bunbury-natural-gas-pipeline/access-arrangements/proposed-access-arrangement-for-period-2016-2020

DBP in its response maintains its initial position – that the Sharpe Lintner CAPM produces biased estimates, whereas the Black CAPM does not. The core of DBP's arguments in rejecting the Sharpe Lintner CAPM in favour of the Black CAPM is as follows:[16]

The major point of difference between DBP and the ERA is in respect of the method for determining a return on equity that will contribute to the allowed rate of return objective as required by Rule 87(5) of the NGR. There are two central issues of difference between DBP and the ERA in respect of the return on equity.

The first of these relates to the problem of bias which is inherent in certain models, with consequential impacts upon the outputs produced by such models, including the ERA's chosen model for estimating the return on equity, the Sharpe-Lintner CAPM. DBP considers that the ERA has not made a proper assessment of its approach to that issue and has based its conclusions on superficial reasoning and irrelevant evidence, while ignoring relevant evidence. Further in at least one respect, the ERA has failed to make a proper application of the evidence which it has itself produced in relation to the identification or quantification of bias within its chosen model. Had it given proper regard to the evidence available to it, we believe the ERA would have reached a different conclusion.

The second issue relates to the need to test outputs. Nowhere does the ERA test whether the outcome of its approach to estimating the return on equity meets Rule 87(5). DBP does this through the use of its model adequacy test. That there is a need to test outcomes as well as inputs is a fundamental aspect of the regulatory framework in the NGL and NGR.

Since DBP does not accept the ERA's rejection of our approach, DBP has maintained substantially the same approach to determining the return on equity from its AA Proposal, that is, the approach of using its "model adequacy test" to consider the outputs of models giving rise to a range of unbiased outcomes; model results that neither systematically overstate or systematically understate actual returns. The data

[14] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016.

[15] Competition Economists Group, *Estimating beta to be used in the Sharpe-Lintner CAPM*, February 2016; HoustonKemp Economists, *Evaluating Forecasts: Response to the ERA's Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020*; February 2016; HoustonKemp Economists, *The Black CAPM: Response to the ERA's Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 - 2020*; February 2016; Data Analysis Australia, *Review of Statistical Aspects of Capital Asset Pricing Model*, February 2016; and Esquant Statistical Consulting, *Review of ERA Cross-Validation Approach*, 24 February 2016..

[16] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. ii.

used for that testing has been updated. Further, DBP has followed the ERA's suggestion that it may implement an alternative way of testing outputs from models (the use of cross validation). That cross validation testing supports DBP's previous findings in relation to the testing of bias for models used to estimate the return on equity.

The ERA notes that the National Gas Rules, and NGR 87 in particular, set out clear requirements for the objective for the setting of the rate of return overall (through the allowed rate of return objective at NGR 87(3)) and the return on equity (NGR 87(5) to 87(7)).

Inter alia, DBP takes direct issue with the views of Partington and Satchell in its response:[17]

6.67 The second piece of evidence the ERA presents is the opinions of various experts. These have, in most cases, been engaged by the AER and not the ERA, but the ERA appears to be endorsing the views of experts as being supportive of its own view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust…

6.68 The conclusion we draw, is that much of the evidence regulators collect in respect of the Black CAPM, leading to the conclusion it is not robust, has been misinterpreted. Variation in estimates of the zero-beta premium is an issue whose importance is overstated, the ERA overlooks key information by ignoring other aspects of the zero-beta premium estimates it produces (like them all being greater than zero) and there are, in any case, serious doubts about the reliability of the regulator's estimates. In conclusion, from examining the ERA's empirical evidence and the views of the AER's experts, the case against the Black CAPM is, in DBP's submission, weak.

Scope of work

This consultancy seeks to evaluate, *in terms of the requirements of NGR 87*:

- the relative strengths and weaknesses of estimating the forward looking return on equity, in an Australian context, using the Sharpe Lintner CAPM or the Black CAPM, or some combination of those models, including;
  - the utility of the ERA's adjustment to the beta for its estimate of the return on equity from the Sharpe Lintner CAPM, informed by the theoretical insights of the Black CAPM;[18]
  - the utility of DBP's approach to estimating the return on equity using empirical results from the Black CAPM, 'transformed' into the Sharpe Lintner framework;
- the utility of DBP's empirical 'model adequacy test' in validating those strengths and weaknesses;
- which approach for estimating the return on equity best meets the requirements of the National Gas Rules;

[17] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, pp. 42 – 43.

[18] By 'utility' we mean the ability of the approach to meet the requirements of NGR 87, including the allowed rate of return objective. The ERA in its gas Rate of Return Guidelines noted a range of criteria which allow it to 'articulate its interpretation of the requirements of the NGL and NGR' (see Attachment 1).

- if there is anything further that the ERA should be aware of in forming its view as to the alternate approach for estimating the return on equity?

Key tasks

The consultancy is split into two stages:

- the first stage will involve evaluating the relevant material and drafting a report which addresses the key requirements (see below); and
- the second stage would involve any extension analysis which is deemed relevant to providing additional evidence to support the Authority's decision on the issues in its final decision.

Key requirements for the consultant in the first stage include:

- familiarising with the range of relevant materials identified in the 'Introduction' section above;
- responding to the criticisms of Partington and Satchell set out by DBP and its consultants Competition Economist Group, HoustonKemp, and in so doing:[19]
  - responding to the DBP's critique that the ERA incorrectly relies on the views of experts such as Partington and Satchell:[20]

    > *…as being supportive of its own view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust.*

  - evaluating DBP's approach for estimating the return on equity using the Black CAPM, given the arguments set out both in its initial proposal and in its revised proposal, including;[21]
    - ♦ DBP's contention that the model adequacy test overcomes the problems associated with the robustness of the Black CAPM approach; and
    - ♦ that aspects of the ERA's own zero-beta premium estimates (for example, all being greater than zero, or, are incorrectly calculated) do not lend support to rejecting the DBP approach;[22] and
    - ♦ that the resulting DBP Black CAPM estimates of the return on equity are unbiased;[23]
  - evaluating the ERA's approach for estimating the return on equity using the Sharpe Lintner CAPM, which takes account of the theoretical insights of the Black CAPM;

[19] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, pp. 42 - 43.

[20] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, pp. 42 – 44; and
DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, Appendices F, G and H.

[21] This evaluation should account for the econometric and statistical analysis of Data Analysis Australia and Esquant Statistical Consulting referenced in the Introduction above.

[22] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, pps. 41 - 42.

[23] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, p. 65; and
DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 41.

- ♦ particularly DBP's contention that the Sharpe Lintner CAPM, even with beta adjusted to the top of its confidence interval range, remains downwardly biased;[24]

- writing a report which integrates this analysis into a recommended way forward for the ERA in terms of estimating a return on equity which meets the requirements of the NGL and NGR;

  - scoping any further econometric or analytical work for a potential second stage that might be required to support that recommended way forward.

[24] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12*, 31 December 2014, p. 63.

Appendix 2

CURRICULUM VITAE GRAHAM PARTINGTON

PERSONAL

Name: Graham Harold Partington

Address: Economics and Business Building (H69),

Finance Discipline, School of Business,

University of Sydney

NSW 2006

Australia

Telephone: +61 (0)2 9036-9429

Email: Graham.Partington@sydney.edu.au

HIGHER EDUCATION AND EMPLOYMENT

Academic Qualifications: B.Sc. (Hons) Economics/Forestry, University of Wales, 1971

MEc. (Hons) by thesis, Macquarie University, 1983.

My current position is Associate Professor of Finance in the Finance Discipline at the University of Sydney. I have been chair of the Finance Discipline and was also head of the postgraduate research program in finance. Concurrent with my position at the University of Sydney I was also the Education Director for the Capital Markets Co-operative Research

Centre PhD program. In a career stretching back more than thirty years I have held Associate Professorships in finance at The University of Technology Sydney and The University of British Columbia. I have also held academic positions at Macquarie University and the University of Bangor I have had extensive teaching and research responsibilities in finance and accounting as well as being head, or deputy head, of University Departments and Schools. I have been very influential in the design of several undergraduate and masters degrees in finance and also PhD programs.

I have written in excess of thirty consulting and expert witness reports covering topics such as valuation, the cost of capital, the value of imputation tax credits, and the market risk premium.

Awards and Major Research Grants

Awards

2013 Best paper prize for accounting, banking economics and finance, Global Business Research Conference.

2012 Bangor University: Honorary Visiting Senior Research Fellow title extended for the period 2013-2016.

2010 The GARP (Global Association of Risk Professionals) Prize for Quantitative Finance/Risk Management/Derivative Instruments, Finance and Corporate Governance Conference.

2009 The CFA (Chartered Financial Analyst) Prize Asian Investments, Asian Finance Association Conference

2009 Bangor University: Honorary Visiting Senior Research Fellow for the period 2009-2012.

2008: PhD students name their rock group after me "The Partingtons"

2001: Manuscript award for the best paper: Education Notes, *Accounting Research Journal,* 2000.

2000: Peter Brownell Manuscript Award. Awarded by the Accounting Association of Australia and New Zealand for the best paper in *Accounting and Finance*, 1999

1985: Butterworths Travelling Fellowship

Major Research Grants

2014-2016 Centre for International Financial Regulation (CIFR), *Measuring Market Quality: Current Limitations and New Metrics*, $170,000.

2007-2014: National Co-operative Research Centre Scheme, grant for the Capital Markets Cooperative Research Centre (CMCRC) $98 million ($49 million in cash and matching in kind contributions.) About $21 million cash over the term of the grant was under my management to run the scholarship and education program.

2000-2003: Australian Research Council, industry linked grant, *Intangibles, Valuation and Dividend Imputation* ($667,000).

1985-1988: Australian Research Grants Scheme, *The Determinants and Consequences of Dividend Policy* ($30,000).

PUBLICATIONS

Books

R. Brealey, S. Myers, G. Partington and D. Robinson, 2000, *Principles of Corporate Finance*, Australian Edition, McGraw-Hill (1st printing 2000, 2nd printing 2000.)

C.A. Martin, J. McKinnon, R. Hines, G. Harrison and G. Partington, 1983, *An Introduction to Accounting*, McGraw-Hill (1st edition, 1983, 2nd edition, 1988, 3rd edition 1990.)

Contributions and Chapters in Books

G. Partington, 2011, Valuation and Project Selection when the Market and Face Value of Dividends Differ, Reprinted in *Asset Management Tools and Strategies,* Bloomsbury Press.

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G. Partington, 2007, Dividend Imputation Credits and Valuation, in *Business Tax Reform*, Australian Tax Research Foundation.

R. J. Coombes, M. Craig-Lees, M. McGrath, P. O'Sullivan, G. Partington and J. M. Wood, 1991, *Business Studies Book Two*, Social Science Press.

R. J. Coombes, M. Craig-Lees, M. McGrath, P. O'Sullivan, G. Partington and J. M. Wood, 1990, *Business Studies Book One,* Social Science Press.

E. Carew, 1985, *The Language of Money,* George Allen and Unwin.

Refereed Journals

PUBLISHED

M. Kim and G. Partington, 2015, The Dynamic Prediction of Financial Distress of Australian Firms, Australian Journal of Management, 40:1, pp.135-60.

A. Ainsworth, K. Fong, D. Gallagher, and G. Partington, 2015, Institutional Trading Around the Ex-Dividend Day*, Australian Journal of Management,* published on-line January, 2015.

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Hodgkinson L and G. Partington, 2013, Capital Gains Tax Managed Funds and the Value of Dividends: the Case of New Zealand, *British Accounting Review*, **45:4**, pp.271-283.

Partington G**.,** 2013, Death Where is Thy Sting? A Response to Dempsey's Despatching of the CAPM, Abacus, **49:S1**, pp. 69-72

Yao J., G. Partington and M. Stevenson, 2013, Predicting the Directional Change in Consumer Sentiment, Australian Journal of Management, **38:1**, pp. 67-80

A. Jun, D. Gallagher and G. Partington, 2011, An Examination of Institutional Dividend Clienteles: Evidence from Australian Institutional Portfolio Holdings, *Journal of Business Finance and Accounting,* **38:1-2,** pp. 198–224.

M. Dempsey, M. McKenzie and G. Partington, 2010, The Problem of Pre-Tax Valuations: A Note, *Journal of Applied Research in Accounting and Finance*, **5:2**, pp. 10-13.

G. Partington and M. Stevenson, 2001, The Probability and Timing of Price Reversals in the Property Market, *Managerial and Decision Economics,* **22:7,** pp.389-398.

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.

G. Partington and S. Walker, 2001, A Note on Transactions Costs and the Interpretation of Dividend Drop-off Ratios, *Accounting and Finance,* **41:2**, pp. 229-241.

S. Walker and G. Partington, 2000, A Market Valuation for Optus Pre-listing: A Case Note, *Accounting Research Journal*, **13:2,** pp. 90-94. (This paper won the award for Best Paper: Education Notes.)

S. Walker and G. Partington, 1999, The Value of Dividends: Evidence from Cum-dividend Trading in the Ex-dividend Period, *Accounting and Finance*, **39:3,** pp. 275-296. (This paper won the Peter Brownell Manuscript Award).

G. Hobbes, G. Partington and M. Stevenson, 1996, Earnings Dividends and Returns: A Theoretical Model, *Research in Finance,* Supplement 2, pp. 221-244.

G. Partington, 1989, Variables Influencing Dividend Policy in Australia: Survey Results, *Journal of Business Finance and Accounting* **16:2,** pp.165-182.

C.A. Martin, J. L. McKinnon and G. Partington, 1986, Funds Statements and the Two Entity Test: A Response, *Abacus*, **22:1**, pp. 39-44.

G. Partington, Discussion of an International Analysis of Dividend Payment Behaviour, 2009, *Journal of Business Finance and Accounting,* **36:3-4**, pp. 523-529.

G. Truong, G. Partington and M. Peat, 2008, Cost of Capital Estimation and Capital Budgeting Practice in Australia, *Australian Journal of Management,* **33:1,** pp. 95- 122.

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L. Hodgkinson and G. Partington, 2008, The Motivation for Takeovers in the UK, *Journal of Business Finance and Accounting*, **35:1-2**, pp. 102-126

Jun, V. Alaganar, G. Partington and M. Stevenson, 2008, Price and Volume Behaviour around the Ex-dividend Day: Evidence on the Value of Dividends from ADRs and their Underlying Australian Stocks*, International Review of Finance*, **8:1-2**, pp. 21-55.

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G. Partington, 2006, Discussion of Dargenidou, Mcleay and Raonic (Expected Earnings Growth and the Cost of Capital: An Analysis of Accounting Regime Change in the European Financial Market) *Abacus* **42:3-4,** pp. 415-425.

S. Armitage, L. Hodgkinson and G. Partington, 2006, The Market Value of UK Dividends from Shares with Differing Entitlements, *Journal of Business Finance and Accounting*, **33:1**, pp 150-174.

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G. Partington, P Russell, M. Stevenson and V. Torbey, 2001, Predicting Return Outcomes for the Shareholders of Companies Entering Chapter 11 Bankruptcy, *Managerial Finance,* **27:4,** pp.78-96.

G. Partington, 1985, Dividend Policy and its Relationship to Investment and Financing Policies: Empirical Evidence, *Journal of Business Finance and Accounting,* **12:4**, pp. 531-542.

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G. Partington, and M. Kim, 2014 *The Dynamic Prediction of Company Failure: The Influence of Time Non-linearity and the Economy*, 2014 China Meeting of the Econometric Society, Xiamen, China, 25 - 27 June.

S. Foley, G. Partington, J. Svec and N. Pritcha, 2014 *The Effects of Underwriting Dividend Reinvestment Plans*, CFA-JCF-Schulich Conference on Financial Market Misconduct, Toronto, April.

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M. McKenzie and G. Partington, 2012, *Selectivity and Sample Bias in Dividend Drop-off Studies*, 10th INFINITI Conference on International Finance, Dublin.

L. Hodgkinson and G. Partington, 2011 *Capital Gains Tax Managed Funds and the Value of Dividends*, Accounting and Finance Association of Australia and New ZealandConference, Darwin.

A. Jun and G. Partington 2011, *Taxes International Clienteles and the Value of ADR Dividends*, 9th INFINITI Conference on International Finance, Dublin.

A. Ainsworth, K. Fong, D. Gallagher, and G. Partington, 2010, *Taxes, Price Pressure and Order Imbalance around the Ex-Dividend Day*, Financial Management Association (FMA) Asian Conference, Singapore

H. Dang and G. Partington, 2010, *The Dynamic Estimation of Rating Migration Hazard*, Finance and Corporate Governance Conference, Melbourne, (Awarded the GARP prize in Quantitative finance/Risk Management/Derivatives).

Partington G and Xu Y 2010, *Rights issue announcements motives and price response,* 8th INFINITI Conference on International Finance - International Credit and Financial Market Integration: After the Storm?, Dublin.

A. Ainsworth, K. Fong, D. Gallagher, and G. Partington, 2009, *Institutional Trading Around the Ex-Dividend Day*, Asian Finance Association Conference, Brisbane. Awarded the CFA best paper prize (Asian Investments.)

H. Dang and G. Partington, 2009, *Rating Migrations: The Effect of History and Time*, Financial Management Association (FMA) European Conference, Turin.

H. Dang and G. Partington, 2008, *Rating History and the Rating Dynamics of Fallen Angels, Rising Stars, and Big Rating Jumpers*, Risk Management Conference: Credit and Financial Risk Management 40 Years after the Altman Z-score Model, Florence.

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M. Dempsey and G. Partington, 2007, *Cost of Capital and Valuation Equations that Work for Any Tax System: Their Application under the Australian Imputation Tax System*, Multinational Finance Society Conference, Thessalonica.

H. Dang and G. Partington, 2007, *Modeling Rating Migrations*, Poster Session, CREDIT Conference, Venice

G. Truong and G. Partington, 2007, *Alternative Estimates of the Cost of Equity Capital for Australian Firms*, 20th Australasian Finance and Banking Conference, Sydney,

G. Partington, 2006, *Dividend Imputation Credits and Valuation*, Business Tax Reform Meet the Critics, Australian Tax Research Foundation Conference, Sydney.

G. Truong and G. Partington, 2006, *The Value of Imputation Tax Credits and Their Impact on the Cost of Capital*, Accounting and Finance Association of Australia and New Zealand Conference, Wellington.

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G. Partington and M. Stevenson, 2006, *A Distress Prediction Tool*, New Directions in Employment and Financial Security: Rethinking Employee Entitlements and Employee Buyouts. Workplace Relations Centre and Members Equity Workshop, Sydney.

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A. McAdam, and G. Partington, 2005, *Does the Choice of Share Price Matter when Examining Takeovers?* Accounting and Finance Association of Australia and New Zealand Conference, Melbourne.

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V. Alaganar, G. Partington and M. Stevenson, 2000, *Do Ex-dividend Drop-offs Differ Across Markets? Evidence From Internationally Traded* (*ADR*) *Stocks*, Accounting Association of Australia and New Zealand Conference, Hamilton Island.

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G Partington and S. Walker, 1999, *The 45-Day Rule: The Pricing of Dividends and the Crackdown on Trading in Imputation Credits*, Accounting Association of Australia and New Zealand Conference, Cairns.

S. Walker and G. Partington, 1999, *Optus: A Market Valuation Pre-listing*, Accounting Association of Australia and New Zealand Conference, Cairns.

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S. Walker and G. Partington, 1997, *The Ex-Dividend Drop-off: Evidence from Cum-dividend Trading in the Ex-dividend Period*, Accounting Association of Australia and New Zealand Conference, Hobart.

G. Hobbes, G. Partington and M. Stevenson, 1995, *Earnings Dividends and Returns: A Theoretical Model,* Asia-Pacific Finance Association Conference, Hong Kong.

G. Partington and E. Hutson, 1994, *Share Prices, Takeover Outcomes and the Expected Value Hypothesis*, invited paper at the University of Wales Finance & Accounting Colloquium, Gegynog.

G. Partington and E. Hutson, 1994, *Share Prices, Takeover Outcome sand the Volume of Trades*, Australasian Finance and Banking Conference, Sydney.

G. Partington, M. Peat and M. Stevenson, 1992, *The Probability and Timing of Corporate Financial Distress: Preliminary Results for Australia,* Australasian Finance and Banking Conference, Sydney.

G. Partington, M. Peat and M. Stevenson, 1991, *Estimating the Probability and Timing of Financial Distress,* Australian Institute of Bankers Conference, Melbourne.

P. Eddey, G. Partington and M. Stevenson, 1989, *Predicting the Probability and Timing of Takeover Success,* Australasian Finance and Banking Conference, Sydney.

G. Partington and T. Valentine 1984, *Finance for Australian Industry*, Metal Trades Industry Conference, Sydney.

G. Partington, 1983, *Why Firms Use Payout Targets: A Comparative Study of Dividend Policy,* Accounting Association of Australia and New Zealand Conference, Brisbane.

Unpublished Working Papers

H. Chu and G. Partington, 2001, *The Market Valuation of Cash Paid into Australian Companies: Evidence from Ex-Rights Day Share Price Behaviour,*.

G. Partington, 1993, *Miller Modigliani and Ohlson: A Note on Old Models in New Clothes,*.

Submissions to Government Inquiries and the Accounting Research Foundation

A. Ainsworth, A. Lee, G. Partington and T. Walter, 2013, *Analysis of ASX Cum Dividend Trading in the Ex Dividend Period 2003-2013: Submission to the Treasury on “Preventing Dividend Washing”,* submission to Treasury Inquiry: Protecting the Corporate Tax base from Erosion and Loopholes - Preventing 'Dividend Washing'

G. Partington, 1991, *Pricing and Capital Adequacy: Are the Banks Getting it Wrong*? a submission to The Australian Banking Inquiry.

G. Partington, 1989, *Accounting in Higher Education*, a submission to The Review of The Accounting Discipline in Higher Education.

J. McKinnon and G. Partington, 1980, *Statement of Sources and Applications of Funds - A Comment on the Exposure Draft,* a submission to the Australian Accounting Research Foundation.

C. Le Gras and G. Partington, 1979, *Commission Rates - Sheep and Cattle Sales,* a submission to the Prices Justification Tribunal.

R. Chenhall and G. Partington, 1979, *Financial Effects of Corporate Taxation,* an invited submission, Australian Financial System Inquiry.

R. Chenhall and G. Partington, 1979, *Submission on Corporate Sector Finance,* a submission to the Australian Financial System Inquiry.

Miscellaneous

G. Partington, 1989, Careers in Finance, *Focus on Careers*; *National Graduate Careers Magazine*. (Updated 1993, at the request of the Department of Education Employment and Training, Careers Reference Centre.)

D. Leece, G. Partington and R. Skellington, 1975, *Not All Over the Audience*, Bangor Arts Festival, Bangor.

D. Leece, G. Partington, D. Power and R. Skellington, 1974, *A Spring Revue,* Bangor Arts Festival, Bangor.

MEMBERSHIPS

Accounting and Finance Association of Australia and New Zealand (Current))

American Finance Association (Current))

American Accounting Association (1978–1992)

European Accounting Association (1984–1987)

Australian Institute of Bankers (1993–1997)

Royal Forestry Society (1978-1984)

CURRICULUM VITAE STEPHEN SATCHELL

NAME Stephen Ellwood SATCHELL

CURRENT POSITION College Teaching Fellow

COLLEGE Trinity College, Cambridge University

DATE OF BIRTH 22nd February 1949

CAREER 1971-73 - School Teacher

1973-74 - Computer Executive

1974-76 - Research Officer

1977-78 - Economic Advisor 10 Downing Street, (part-time)

1978-79 - Lecturer (Statistics Department) at LSE

1979-80 - Lecturer (Economics Department) at LSE

1980-86 - Lecturer, University of Essex

1986-2014 - Fellow(Title C), Trinity College

1986-89 - Assistant Lecturer, University of Cambridge

1989-2000 - University Lecturer at the University of Cambridge

1991-93 - Reader, Birkbeck College

2000-2009 - The Reader of Financial Econometrics, Cambridge University.

2010-2012 - Visiting Professor, Sydney University.

2011 The Emeritus Reader of Financial Econometrics, Cambridge University.

2012- 2014 -Visiting Lecturer ,RHUL, London University

2013 -Professor, Sydney University

2014 - Fellow(Title E), Trinity College

CURRENT RESEARCH

I am working on a number of topics in the broad areas of econometrics, finance, risk measurement and utility theory. I have an interest in both theoretical and empirical problems. Many of my research problems are motivated by practical investment issues. My current research looks at alternative methods of portfolio construction and risk management, as well as work on non-linear dynamic models. I am active in researching the UK mortgage and housing markets.

I have strong links with Inquire (Institute for Quantitative Investment Research). This is a city-based organization that finances academic research on quantitative investment. I am also on the management committee of LQG (London Quant Group).

JOURNAL AFFILIATIONS

I am the Founding Editor of *Journal of Asset Management* (Palgrave Macmillan publishers) first issue, July 2000

I am the Series Editor of a book series, *Quantitative Finance* (Academic Press/Elsevier publishers).

I am the Editor of *Journal of Derivatives and Hedge Funds* (Palgrave Macmillan publishers). I am on the Editorial Board of *Applied Financial Economics*, *Journal of Financial Services Marketing*, *Journal of Bond Trading and Management. QASS, Journal of Financial Policy* and *European Journal of Finance* and senior associate editor of *Journal of Mathematical Finance.*

I am the Founding Editor of a journal for Incisive-Media Ltd, *Journal of Risk Model Validation.* and was editor for another of their journals, *Journal of Financial Forecasting.*

SUBMITTED PUBLICATIONS

Estimating Consumption Plans for Endowments with Recursive Utility by Maximum Entropy Methods, (with S. Thorp and O. Williams), submitted to *Applied Mathematical Finance*

Aligned with the stars: the Morningstar rating system and the cross-section of risk aversion (with S. Thorp and R. Louth)

"Individual capability and effort in retirement benefit choice" (with H. Bateman, S. Thorp, , J. Louviere, C. Eckert) submitted to *Journal of Risk and Insurance*

("Default and Naive Diversification Heuristics in Annuity Choice",(with H. Bateman, S. Thorp, , J. Louviere, C. Eckert) submitted to *Journal of Behavioural Finance*

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Theoretical Decomposition of the Cross-Sectional Dispersion of Stock Returns(with A.Grant) forthcoming in *Quantitative Finance. A*

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BOOKS AND UNPUBLISHED PAPERS

A) BOOKS

Advanced Statistical Methods in Social Sciences, Francis Pinter (with Dr. N. Schofield, M. Chatterjii, and P. Whiteley), 1986.

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B) PAPERS (PAST)

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On the Use of Revenues to Assess Organizational Risk (with R. Lewin).

Improving the Estimates of the Risk Premia – Application in the UK Financial Market, DAE Working Paper No. 0109, University of Cambridge. (With M. Pitsillis) 2001

Ex-Ante versus Ex-Post Excess Returns, mimeo. (with D. Robertson) 2001.

The Impact of Technical Analysis of Asset Price Dynamics, DAE Working Paper No. 0219, University of Cambridge. (With J-H Yang) 2002.

A Bayesian Confidence Interval for Value-at-Risk. Submitted to theDAE Working Paper Series. (with Contreras, P.). 2003

PAPERS (CURRENT)

"Using the Large Deviation Technique to Estimate Asymmetric Financial Risk", Institute for Financial Research, Birkbeck College, IFR 1/2003 (with Ba Chu and Knight, J.). 2003

A Bayesian Confidence Interval for Value-at-Risk. Submitted to theDAE Working Paper Series. (with Contreras, P.). 2003

The Impact of Background Risks on Expected Utility Maximisation (with V. Merella).

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Information Ratios, Sharpe Ratios and the Trade-off Between Skill And Risk (with P. Spence and A.D. Hall)

The Impacts of Constraints on the Moments of an Active Portfolio (with P. Spence and A.D. Hall)

Exact Properties of Optimal Investment for Institutional Investors (with J. Knight), Birkbeck College WP, 0513, 2005.

Distribution of Constrained Portfolio Weights and Returns, (with J. Knight,).

Improved Testing for the Validity of Asset Pricing Theories in Linear Factor Models, Financial Econometric Research Centre working paper WP99-20, Cass Business School. (With S. Hwang) 2001.

Optimal Portfolio for Skew Symmetric Distributions, (with R. Corn).

Scenario Analysis with Recursive Utility: Dynamic Consumption Paths for Charitable Endowments, (with S. Thorp), working paper, UTS.

Incorporating Gain-Loss and Mean-Variance in a Single Framework, (with S. Cavaglia, and K. Scherer).

'Heuristic Portfolio Optimisation: Bayesian Updating with the Johnson Family of Distributions', Callanish Capital Partners Technical Paper (with R. J. Louth)

'The Impact of Ratings on the Assets Under Management of Retail Funds', S&P Internal Report, (with R. J. Louth).

'The Impact of Ratings on the Performance of Retail Funds', S&P Internal Report (with R. J. Louth)

Are There Bubbles in the Art Market? (with N. Srivastava)

EDUCATION

1965-9 - BA in Economics, Mathematics, Statistics and Politics, University of New South Wales.

1971 - Diploma in Education, Balmain Teachers' College

1972 - Teachers Certificate, Department of Education, NSW

1972-73 - MA in Mathematics, University of Sydney

1974-75 - M. Commerce in Economics, University of New South Wales

1976-80 - Ph.D. in Economics, University of London (The Ph.D. was supervised by Professor J.D. Sargan), examined by P. Phillips and D. Sargan.

1990 - MA (Cambridge).

1995 - Ph.D (Cambridge), examined by P. Robinson and P. Schmidt.

2001 - FIA (Institute of Actuaries) Honorary

SUPERVISION

1987-2007 Have supervised students from all colleges in Paper 12, now Paper 11. Have supervised papers 1, 2, 5, 6 of Prelim and papers 7, 11, and 12 of Part 2 (now 6, 10, and 11).

TEACHING

1973 - Taught for two years in high school, was inspected and received Teacher's Certificate.

1975 - Taught again at NCR, learnt and taught various computing languages.

1976-78 - Taught Introductory Econometrics in a September Mathematics Course to MA in Economics students at the LSE.

1977 - Whilst Lecturer in Statistics, taught:

(i) post-graduate course in Causal Analysis

(ii) post-graduate course in Advanced Time-Series

1978 - Shared courses in Econometric Theory

1979-86 - At Essex: Taught courses in Econometric Theory

(i) Statistics

(ii) Econometrics

(iii) Computing

(iv) Mathematical Economics

(v) Finance

1987-90 - Finance, Econometrics (Cambridge Papers 12, 25, 31)

1990-91 - Taught Advanced Econometrics at Birkbeck.

1991-92 - Taught Introduction to Mathematical Economics.

Advanced Econometrics.

BASE (Birkbeck Advanced Studies in Economics) course on Finance

1992-93 - Taught September course Mathematics, taught Theory of Finance (M.Sc.), Financial Econometrics (M.Sc.), Financial Econometrics (B.Sc.).

1993-2004 - Taught Papers 7, 12, 31 201, 231, 301 and 321 (not all simultaneously).

2005-2007 Taught Papers 7, 11, and 403, also taught Risk Management in Msc, Financial Engineering, Birkbeck , and Corporate Finance, University of Sydney.

CONSULTING EXPERIENCE

My consulting experience is very extensive, particularly in the areas of asset management and investment technology. I have supervised the building and maintenance of portfolio risk models. I have organised conferences for risk managers, investment professionals, and academics. I have carried out risk analysis on investment strategies and investment products. I can provide specific details on any of these areas if requested. I have worked with large numbers of international financial institutions and can provide testimonies as to my value – added if required.

I also work in mortgages, house prices, and real estate generally; recently, I designed with G. Christodoulakis the FT House Price Index for Acadametrics. I have also built mortgage default and loss models for Acadametrics. In conjunction with Acadametrics, I have been involved in the validation of risk models for lending institutions; this has been part of Basle II work in the recent past.

GENERAL CONTRIBUTION

I received colours from the LSE for cross-country running in 1977 and 1978 . I was also Secretary of London University Cross-Country Club 1978. I represented Trinity College at cross-country running 1987-1988, completed the London Marathon on 5 occasions, best 3.04.41 (1987). I was reserve for Cambridge University Marathon Team (1990). In recent years, I ran 10 km in 44.32, Oct 2000, 44.05 in Mar, 2001; 44.48 in Jan, 2003, 44.52 in March 2005 , 42.53 in Feb, 2006, 44.24 in April 2007. I have won a number of medals in Veteran's road running.

CAMBRIDGE FACULTY ADMINISTRATION

At various stages I have been on:

Management Board for Management Studies Tripos

Statistics Committee (Chair)

Graduate Admissions Committee, was acting Admissions Officer 1989

Organised Seminar Series in Finance

Organising Seminar Series in Econometrics

Future Needs and Lecture List Committee

Faculty Board

Appointments Committee

College Administration

Director of Studies (1987- 2011) and Director of Admissions in Economics (1987-1994)

Trinity College

Finance Committee (1991-2003) ,2008 to 2011 and Treasurer of Trinity in Camberwell (charity) (1989-1992) plus other minor committees. Inspector of Accounts 1994-5 and 1996-97.

Wine Committee from 2005 to 2012.

Birkbeck Administration 1991-92

Department Seminar Organiser

Chairman Finance Examinations

Appointments Committee

Ph.D. Admissions

M.Sc. Finance Admissions

Jointly responsible for the creation of the new M.Sc. Finance (currently 70 students) which has now run successfully for 15 years.

Cambridge Administration 1993 to present

Appointments Committee

M.Sc. Finance Admissions

Chairman Finance Exams

M.Sc. Finance Co-ordinator

<u>1993-94</u> Coordinator Papers 12, 31, 201, 231.

MSc Finance Admissions

<u>1994-95</u> Coordinator Papers 12 and 231.

<u>1995-96</u> Coordinator Papers 12, 201,231. Chairman ETE Exams.

<u>1996-1999</u> Coordinator Papers 7 and 12.

<u>1999-2000</u> Acting Graduate Chairman

<u>2000-2001</u> Coordinator Paper 301.

<u>2002-2006</u> Coordinator Papers 6 and 11. Head of Part 1 Examiners (2004).

PROFESSIONAL CONTRIBUTIONS

Refereeing

I have refereed articles for the *Journal of Econometrics*, *Econometrica, IER*, *Mathematical Social Sciences*, *Journal of Public Economics*, *Review of Economic Studies*, *Econometric Theory*, and *Journal of Applied Econometrics* plus many other journals.

Visiting and Seminars

I have given seminars at many British and Australian Universities and have been a visitor at Monash University (1985), (1987) and the University of New South Wales (1986) and Australian National University (1986), (1987). I have visited the University at Western Ontario (1988) and been a Visiting Fellow to University College, London. In 1989, I visited Complutense, Madrid. I am currently 4 times a Visiting Professor at Birkbeck College, London (1994 -). I recently visited University of Technology, Sydney (1998-2006). I have been appointed Visiting Professor at CASS/CUBS (2000-2006) and Visiting Professor at Birkbeck College (2000-2006) and Visiting Lecturer in Applied Mathematics at Oxford University (2002-2004). I am currently an Adjunct Professor at UTS (Sydney), and have had an association since 1997.

Supervision and Examination

I have supervised numerous post-graduate students and have successfully supervised the Ph.D.'s of A. Nasim at Essex and of M. Ncube and Y. Yoon, B. Eftekhari and S Hwang, G. Kuo, C. Pedersen, M. Sokalska, S. Bond, L. Middleton(Judge), M. Pitsillis, T. Darsinos, A. Sancetta, S. Yang, R. Lewin(Judge), G. Davies, W. Cheung , R. Corns, O. Williams and P. Contreras ,J.Zhang, R. Louth, Jimmy Hong, Nandini Srivastava, Omri Ross(Maths) at Cambridge, plus other Cambridge students on a joint supervision basis including A. Timmermann and L. Shi. Other successful PhD students supervised at Birkbeck include Y. Hatgioniddes, R. Daccó, M. Karanassou, G. Christodoulakis , B. Chu , Wei Jin, Wei Xia , Riko Miura and John Wylie from Sydney University.

My current students consist of four Cambridge Ph.D. students in Economics and three Birkbeck students. Plus one from Sydney University I have been an Examiner every year that I have taught at University. I have been external examiner at Queen Mary College and London School of Economics (Econometrics), and at London School of Economics (Economics), Imperial College, and Essex University. I have also examined over forrty doctoral dissertations in Econometrics, Finance and Land Economy at universities in Great Britain, Europe, Canada, and Australia.

Awards and Prizes

My research project was awarded a prize (the Inquire Prize for the best presentation at the annual Inquire Conference, Bournemouth, 1991 value £3,000).

Received Econometric Theory Multa Scripsit Award (1997).

My paper The Pricing of Market-to-Market Contingent Claims in a No-Arbitrage Economy was runner-up 1997 E. Yetton Award for the best paper published in AJM (1997).

Received Honorary Membership of the Institute of Actuaries (2001), received F.I.A.

Fund Raising

I have raised well in excess of £1,000,000 since 1991, I give details below:

I raised £105,000 for a financial econometrics project, the research was done at the Department of Applied Economics (Cambridge). This was funded by Inquire and the Newton Trust. The research project brought Professor W. Perraudin to Cambridge and employed Y. Yoon.

I have received £9,000 from the Newton Trust for 1993-94; and have had 2 research grants from ESRC joint with W. Perraudin, total value about £60,000. I have received £17,500 from Inquire for 93-94. I have received a further £20,000 from the Newton Trust (1993).

I started a new research project on the Econometrics of Emerging Markets. I received £30,000 from the Newton Trust (1994) and £10,000 from Inquire (1995) and £30,000 from Kleinwort Benson Investment Management (1995) plus a further £28,000 from Alpha Strategies (1998). This project has employed R. Daccó, and S. Huang.

I received £26,000 from the DSS to work on Pension Funds (joint with C. Pratten). I received £10,000 from Inquire (1996). I received a further £10,000 from Inquire (1997). In 1998, I received £7,500 for research on trading rules from a private donor and a further £25,000 from the Newton Trust. I received £4,500 research donation from Alpha Strategies and £2,500 from General-Re to speak at their annual conference (joint with C. Pratten), plus £6,500 from

Inquire (1998) and £9,000 from Inquire (2000), £8,000 from Inquire (2003) and a grant of £6,000 from Acadametrics to employ J. Zhang.

I have received an ESRC grant of £80,000, which employed A. Sancetta for two years (2003-2004).

In 2005 I received with S. Hwang and B. Chu £45,000 from the ESRC to research on risk-management and non-linear correlation.

I have also received two grants of 3000 pounds each from Reading University(2005-2006) to work on real estate finance and a grant of (approx.) 20.000 pounds in 2006,joint with S.Bond and S.Hwang to work on asset allocation issues, the grant being from IRF.

Summary of Discovery Project Proposal for Funding to Commence in 2010

DP1093842 A/Prof HJ Bateman; Prof JJ Louviere; Dr SJ Thorp; Dr C Ebling; A/Prof T Islam; Prof S Satchell; Prof JF Geweke

Approved The paradox of choice: Unravelling complex superannuation decisions

Approximately A$960,0000

CIFR Grant Graham Partington, Steve Satchell, Richard Philip, Amy Kwan Measuring market quality: current limitations and new metrics $140,000 total

CIFR Grant: Identifying Asset Price Bubbles in Australian Listed Securities

$122,000 total

<u>Popular Articles</u>

Making Money Out of Chaos, Investors Chronicle, 10th July 1992. (Interview)

Articles in the *International Broker*, (with Allan Timmermann), (15 pieces), listed next.

Weekly columns on Investment Techniques:

Equity switch programme (Vol. 6, page 7)

Making money out of chaos (Vol. 7, page 6)

Where random walks trips up (Vol. 8, page 7)

Ignorance can be profitable (Vol. 9, page 7)

Making money from market volatility (Vol. 10, page 7)

High-low prices in options trading (Vol. 11, page 7)

Can heavy trading be profitable? (Vol. 12, page 7)

Economic variables show stock returns (Vol. 13, page 7)

No mean return on shares (Vol. 14, page 9)

Do option prices augur a crash? (Vol. 15, page 9)

Puzzles in closed-end fund prices (Vol. 16, page 9)

Capital asset pricing model challenged (Vol. 17, page 9)

How dividends affect share prices (Vol. 18, page 9)

The relationship between price and volume (Vol. 19, page 9)

How persistent are financial market shocks? (Vol. 22, page 9)

Research work written up by International Management (April 1993).

Article in the *Professional Investor* (May 1995), Short-termism (with D.C. Damant), (pages 21-27).

Article in the *Professional Investor* (July 1995), Accounting for Derivatives (with D.C. Damant).

Book Review on Ethnic Minorities and Higher Education in *Higher Education Review*, 1996, 28:2, 96.

Article in the *Professional Investor* (June 1996), Downside Risk (with D.C. Damant).

Contribution to discussion British *Actuarial Journal*, Volume 3, Part I, pages 10-11, 1997

Contribution to discussion British *Actuarial Journal*, 1998.

Article on Lloyd's Syndicate Valuations Methodology, (*ALM News*), 1998.

Research discussed in Observer (26th April 1998, page 11).

Research discussed in Inside Monthly (April 1998, pages 12-14).

Interviewed on Bloomberg TV (27th February 1998)

Pension Scheme Investment Policies, DSS Research Report No. 82 (with C. Pratten), 1998.

Designed the FT Acadametrics House Price Index, 2003. This Index appears monthly in the FT and is

usually discussed by journalists and market pundits.

Contribution to discussion, British *Actuarial Journal,* 2006.

The Impact of Utility on Endowment Strategy, *Professional Investor, April 2007.*

Interviewed on ABC re financial crisis(October 2008)

Research Affiliations (past and present)

Head of Research,Bita-Risk.

Academic Advisor, Alpha Strategies

Advisory Panel, IFC (Subsidiary of the IMF)

Academic Advisor, Kleinwort Benson Asset Management

Academic Advisor Kiln Colesworth Stewart (Member's Agents, Lloyds)

Academic Panel, Panagora Asset Management (1992-1998)

U.K. Representative, Pension Research Institute (State University of California)

Fellow, Pensions Institute (Birkbeck College)

Academic Adviser, Quantec

Academic Panel, State Street Global Advisors

Research Advisor, Thesys Forecasting, currently Acadametrics.

Visiting Professor, Cass Business School, City University,

Visiting Professor University of Technology, Sydney.

Visiting Professor, Birkbeck College.

Honorary Visiting Professor University of Sydney

Academic Advisor, Style Research Associates

Visiting Lecturer, University of Oxford, applied mathematical finance diploma.

Academic Adviser, Northern Trust.

Academic Advisory Board, Old Mutual Asset Management.

Expert Witness between fund Manager and Pension Fund., 2003.

Expert Witness between fund Manager and Pension Fund, 2004-2006.

Expert Witness between Insurance Company and Lettuce Grower.

Adviser in Risk Management to the Governor of the Bank of Greece.

Head of Research, BITA Risk..

Member, Advisory Board, Quantitative Finance Research Centre, UTS.

Member, Steering Committee, CIMF, Cambridge University.

Area Coordinator, Fundamentals of Economic Analysis, Libros de Economia y Empresa, Real Academia de Ciencias Morales Y Politicas.

Consultant, JP Morgan AM,Behavioural Equity Team.

Academic Advisor, Lombard-Odier Asset Management.

Program Committees

European Meeting of the Econometric Society (1997)

Forecasting FX Conference organized by Imperial College and B.N.P. (1996 to 2007)

Inquire UK (2006, 2007)

Program Committee, UK Inquire.

Prize Committee, European Inquire.

Conferences and Seminars

NZ Econometric conference, feb,2011.

Conferences and Seminars (2009)

Presented seminars at:
Sydney University (April 3rd);
Macquarie Bank (April 7th),
CRMC Sydney (April 8th);
Sydney Q group, April 15th.

Conferences (2008)

Finance Conference, London, October, key-note speaker.

Chair, LQ conference (Cambridge, September), presented.

Prize Committee, Inquire Europe(Bordeaux, October).

Conferences (2007)

Finance Conference, Imperial College, March 2007, Discussant.

Finance Conference, Zurich, March 2007. Invited Key Note Speaker.

Alpha Strategies Finance Conference, April 2007, Duke University, chaired conference.

UKSIP Lecture on Endowments, April 2007.

Alpha Strategies Finance Conference, September 2007, Oxford University, chaired conference.

Conferences (2006)

Alpha Strategies Finance Conference, April 2006, Duke University, chaired conference.

Risk Management Conference, June 2006, Bank of Greece, Athens. Gave paper, helped organize programme.

Asset Allocation Summit, July 2006, London, presented paper.

New Zealand Econometrics Conference Dunedin August 2006, chaired session, gave paper, was on prize committee.

Alpha Strategies Finance Conference, September 2006, Cambridge University, chaired conference.

Appendix 3

FEDERAL COURT OF AUSTRALIA

Practice Note CM 7

EXPERT WITNESSES IN PROCEEDINGS IN THE

FEDERAL COURT OF AUSTRALIA

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

Commencement

1. This Practice Note commences on 4 June 2013.

Introduction

2. Rule 23.12 of the Federal Court Rules 2011 requires a party to give a copy of the following guidelines to any witness they propose to retain for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based on the specialised knowledge of the witness (see **Part 3.3 - Opinion** of the *Evidence Act 1995* (Cth)).

3. The guidelines are not intended to address all aspects of an expert witness's duties, but are intended to facilitate the admission of opinion evidence[25], and to assist experts to understand in general terms what the Court expects of them. Additionally, it is hoped that the guidelines will assist individual expert witnesses to avoid the criticism that is sometimes made (whether rightly or wrongly) that expert witnesses lack objectivity, or have coloured their evidence in favour of the party calling them.

Guidelines

[25] As to the distinction between expert opinion evidence and expert assistance see *Evans Deakin Pty Ltd v Sebel Furniture Ltd* [2003] FCA 171 per Allsop J at [676].

1. General Duty to the Court[26]

1.1 An expert witness has an overriding duty to assist the Court on matters relevant to the expert's area of expertise.

1.2 An expert witness is not an advocate for a party even when giving testimony that is necessarily evaluative rather than inferential.

1.3 An expert witness's paramount duty is to the Court and not to the person retaining the expert.

2. The Form of the Expert's Report[27]

2.1 An expert's written report must comply with Rule 23.13 and therefore must

(a) be signed by the expert who prepared the report; and

(b) contain an acknowledgement at the beginning of the report that the expert has read, understood and complied with the Practice Note; and

(c) contain particulars of the training, study or experience by which the expert has acquired specialised knowledge; and

(d) identify the questions that the expert was asked to address; and

(e) set out separately each of the factual findings or assumptions on which the expert's opinion is based; and

(f) set out separately from the factual findings or assumptions each of the expert's opinions; and

(g) set out the reasons for each of the expert's opinions; and

(ga) contain an acknowledgment that the expert's opinions are based wholly or substantially on the specialised knowledge mentioned in paragraph (c) above[28]; and

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[26]The "*Ikarian Reefer*" (1993) 20 FSR 563 at 565-566.
[27] Rule 23.13.

(h) comply with the Practice Note.

2.2 At the end of the report the expert should declare that "[the expert] has *made all the inquiries that* [the expert] *believes are desirable and appropriate and that no matters of significance that* [the expert] *regards as relevant have, to* [the expert's] *knowledge, been withheld from the Court*."

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

2.4 If, after exchange of reports or at any other stage, an expert witness changes the expert's opinion, having read another expert's report or for any other reason, the change should be communicated as soon as practicable (through the party's lawyers) to each party to whom the expert witness's report has been provided and, when appropriate, to the Court[29].

2.5 If an expert's opinion is not fully researched because the expert considers that insufficient data are available, or for any other reason, this must be stated with an indication that the opinion is no more than a provisional one. Where an expert witness who has prepared a report believes that it may be incomplete or inaccurate without some qualification, that qualification must be stated in the report.

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

2.7 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the opposite party at the same time as the exchange of reports[30].

3. Experts' Conference

3.1 If experts retained by the parties meet at the direction of the Court, it would be improper for an expert to be given, or to accept, instructions not to reach

[28] See also *Dasreef Pty Limited v Nawaf Hawchar* [2011] HCA 21.
[29] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565
[30] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565-566. See also Ormrod *"Scientific Evidence in Court"* [1968] Crim LR 240

agreement. If, at a meeting directed by the Court, the experts cannot reach agreement about matters of expert opinion, they should specify their reasons for being unable to do so.

J L B ALLSOP

Chief Justice

4 June 2013