Cost of equity in the Black Capital Asset Pricing Model

Report for Jemena Gas Networks, ActewAGL, Networks NSW, Transend, Ergon and SA Power Networks

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SFG CONSULTING

Level 1, South Bank House
Cnr. Ernest and Little Stanley St
South Bank, QLD 4101

PO Box 29
South Bank, QLD 4101

Email: s.gray@sfgconsulting.com.au
Office: +61 7 3844 0684
Phone: +61 419 752 260

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1. Background and conclusions

Overview and instructions

1. SFG Consulting (**SFG**) has been retained by Jemena Gas Networks (**JGN**), ActewAGL, Networks NSW, Transend, Ergon and SA Power Networks to provide our views on the estimation of the required return on equity using the Black (1972) version of the Capital Asset Pricing Model (**CAPM**) under the National Electricity Rules and National Gas Rules (**Rules**). In particular, we have been asked to provide an opinion report that:

   a) describes the Black CAPM, its key parameters and inputs, and the theoretical and empirical basis for its development;

   b) describes how the Black CAPM is applied in practice (and is used to estimate the return on equity) in Australia;

   c) uses the Black CAPM to estimate the return on equity for a benchmark efficient entity in Australia that is:

      i) commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies in respect of the provision of reference services; and is

      ii) reflective of prevailing conditions in the market for equity funds.

2. In preparing the report, we have been asked to:

   a) consider different approaches to applying the Black CAPM and estimating the zero-beta premium, including any theoretical restrictions on empirical estimates;

   b) consider the stability of estimates of the zero-beta premium over time;

   c) consider any comments raised by the Australian Energy Regulator (**AER**) and other regulators about (i) whether the Black CAPM applies in Australia and (ii) the best estimate of the zero-beta premium for Australia;

   d) use robust methods and data; and

   e) use the sample averaging period of the 20 business days to 12 February 2014 (inclusive) to estimate any prevailing parameter estimates needed to populate the Black CAPM.

3. Our instructions are set out in Appendix 1 to this report.

4. This report has been authored by Professor Stephen Gray and Dr Jason Hall. Stephen Gray is Professor of Finance at UQ Business School, The University of Queensland and Director of SFG Consulting, a specialist corporate finance consultancy. He has Honours degrees in Commerce and Law from The University of Queensland and a PhD in financial economics from Stanford University. He teaches graduate level courses with a focus on cost of capital issues, has published widely in high-level academic journals, and has more than 15 years' experience advising regulators, government agencies and regulated businesses on cost of capital issues. Jason Hall is Lecturer in Finance at the Ross School of Business, The University of Michigan and Director of SFG Consulting. He has an Honours degree in Commerce and a PhD in finance from The University of Queensland. He teaches graduate level courses with a focus on valuation, has published 15 research papers in academic

journals and has 17 years practical experience in valuation and corporate finance. Copies of the authors' curriculum vitas are attached as an appendix to this report.

5. The opinions set out in this report are based on the specialist knowledge acquired from our training and experience set out above.

6. We have read, understood and complied with the Federal Court of Australia Practice Note CM7 *Expert Witnesses in Proceedings in the Federal Court of Australia*.

Summary of conclusions

7. Our primary conclusions in relation to the estimation of the allowed return on equity are set out below.

8. The Black CAPM can be contrasted with the Sharpe-Lintner CAPM.[1] Both models estimate the cost of equity as a function of only one type of risk, systematic risk, which is also termed market risk or economic risk. Both models also rely upon a set of restrictive assumptions that do not hold in reality. In both cases there is an assumption that all investors have access to the same information, investors have the same expectations for risk and return of all assets, and investors can trade without impediments like taxes, transaction costs and illiquidity.

9. However, there is one important theoretical difference between the two models. Underpinning the Sharpe-Lintner CAPM is an assumption that investors can borrow and lend at the risk-free rate of interest.[2] It is this assumption which directly leads to the equation which states that the expected return on a risky asset is equal to the risk-free rate of interest (r_f) plus a premium for bearing systematic risk [beta × market risk premium = $\beta \times (r_m - r_f)$]. Beta is the measure of systematic risk and the market risk premium (**MRP**) is the increase in the cost of capital per unit of risk.

10. The Black CAPM does not rely upon the assumption that all investors can borrow at the risk-free rate of interest. Rather, the Black CAPM relies upon the assumption that investors can short sell risky assets. In reality, investors do not have infinite power to short sell every risky asset, but we know that they can short sell to some degree. This alternative assumption leads directly to the equation which states that the expected return on a risky asset is equal to the return on a zero beta asset (r_z) plus a premium for bearing systematic risk [$\beta \times (r_m - r_z)$]. The *zero beta premium* refers to the difference between the return on a zero beta asset and the risk-free rate ($r_z - r_f$).

11. The Sharpe-Lintner CAPM does not perform well in being able to explain the returns we actually observe on listed stocks. In particular, stocks with low beta estimates earn higher returns than predicted by the Sharpe-Lintner CAPM, and stocks with high beta estimates earn lower returns than predicted by the Sharpe-Lintner CAPM. This empirical result has been documented in literature over 50 years, and this empirical observation is one reason behind the theoretical development of the Black CAPM. Researchers wanted to understand why the Sharpe-Lintner CAPM was not supported by stock return data. The poor empirical performance of the Sharpe-Lintner CAPM likely occurs for two reasons. First, risks other than systematic risk are incorporated into share prices (in particular, stocks with a high book-to-market ratio persistently earn higher returns than stocks with a low book-to-market ratio). Second, the common measurement of systematic risk – the regression coefficient of excess stock returns on market returns – is an imprecise measure of risk.

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[1] Sharpe (1964) and Lintner (1965).

[2] For practical purposes this would mean that private investors would be able to borrow at the same rates we observe on government bonds. Governments are able to borrow at low rates because they have the power to raise taxes to cover their debts.

12. The empirical evidence on the Sharpe-Lintner CAPM suggests that the intercept term in the CAPM should lie above the risk-free rate of interest, and the return per unit of risk will be less than the market risk premium. As the intercept increases and the return per unit of risk falls the expected return on stocks with low beta estimates goes up, and the expected return on stocks with high beta estimates goes down. So the empirical evidence is consistent with the Black CAPM, with an input for r_z which is above r_f.

13. In theory, we would also expect the zero beta return (r_z) to lie below the expected market return (r_m). If the zero beta return lies above the market return the implication is that investors would require lower returns for bearing more risk. All else being equal, investors would pay a higher price for a stock with beta of 1.5 compared to a stock with beta of 0.5. However, this basic theory will not necessarily show up in the data because two things are measured with imprecision. First, the proxy for the market portfolio of all risky assets is an index of listed stocks. Second, analysis is performed with respect to realised returns and not expected returns, so relies upon the assumption that there is enough historical information in realised returns for noise in different directions to cancel out.

14. In a prior submission the AER was presented with a report from NERA Economic Consulting (2013) in which the authors reported a number of estimates of the zero beta premium. The researchers use two different compilation techniques and compile estimates on the basis of portfolio returns and individual security returns. Based upon their full sample of 39 years of returns from 1974 to 2012, the range of zero beta premium estimates from these four sets of analysis is from 8.74% year to 13.95% per year.[3]

15. The standard error of the zero beta premium estimates means that none of the zero beta premium estimates are different from the values for the market risk premium previously adopted by the AER, of 6.0% and 6.5%.[4] This means that it cannot be established, statistically, that the expected return of a stock with a low beta estimate, or a high beta estimate, is any different from the expected return on the average stock in the market. It means that the foundation model in the AER Guideline, the Sharpe-Lintner CAPM, is not supported by analysis of historical returns on Australian-listed stocks.

16. In the current paper, we report a different estimate of the zero beta premium. Using 20 years of returns information from 1994 to 2013, we estimate a zero beta premium of 3.34% per year. So the estimate of the zero beta premium lies below the market risk premium estimates of 6.0% and 6.5% previously used by the AER. However, this difference is not statistically significant. Consistent with the analysis previously presented to the AER, it cannot be statistically determined that the expected return on a stock with a low beta estimate, or a high beta estimate, is any different from the expected return on the average stock in the market. It remains the case that the foundation model in the AER Guideline, the Sharpe-Lintner CAPM, is not supported by analysis of historical returns on Australian-listed stocks.

17. The reason our point estimate of the zero beta premium is lower than the AER's market risk premium estimate of 6.5%, and NERA's (2013) estimates are higher than the AER's market risk premium estimate is as follows. When we formed portfolios to measure the relationship between beta estimates we formed portfolios that had approximately the same industry composition, market capitalisation, and book-to-market ratio. So we isolated the relationship between stock returns and beta estimates that was largely independent of other stock characteristics that are associated stock

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[3] NERA (2013), Sub-section 5.2, Table 5.2, p. 16, and Sub-section 5.5, Table 5.6, p. 23. This is the range of the four point estimates. It does not represent the ranges around those point estimates.

[4] In the current AER Guideline the AER (2013b, p.11) has adopted an estimate for the market risk premium of 6.5%. In most prior decisions the AER has adopted an estimate for the market risk premium of 6.0%. An exception is during the global financial crisis when the AER adopted an estimate of the market risk premium of 6.5%.

returns.[5] We repeated our analysis after forming portfolios entirely on the basis of beta estimates and found that the zero beta premium was 9.28%. This estimate of the zero beta premium is almost identical to the portfolio return of 10.03% reported by NERA for the 19-year period from 1994 to 2012.[6]

18. This has the following implication for estimating the cost of equity.

    a) If we *assume* that stocks are priced only on the basis of systematic risk, the best estimate of the cost of equity from the historical data is given by the following equation:

    $$r_e = r_z + \beta_e \times (r_m - r_z), \text{ and } r_z = r_f + 3.34\%.$$

    In a companion report we provide estimates of the cost of equity under alternative equations that do not incorporate the assumption that stocks are priced according to only systematic risk.[7] We provide estimates of the cost of equity for the benchmark firm using the Fama-French model[8] and the dividend discount model because the weight on empirical evidence is that (1) the book-to-market factor is a priced risk factor for Australian-listed stocks, and (2) we are able to compile cost of equity estimates using the dividend discount model in which we do not need to specify, in advance, what risks we assume are, or are not, incorporated into stock prices.

    b) If there is not consideration of cost of equity estimates from other models, both our analysis and that of NERA (2013) support the conclusion that we cannot differentiate the expected return on a low beta stock, or a high beta stock, from the overall market return. If either the Sharpe-Lintner CAPM, or the Black CAPM, was used without consideration of any other risks, this would be inconsistent with historical returns. The reason the zero beta premium is higher than the market risk premium when portfolios are formed only from beta estimates is *because* stock returns are associated with characteristics other than beta.

    c) Putting implication (a) and (b) together, this means that the best estimate of the cost of equity can be made using the Black CAPM *and* information that accounts for other risks. If information that accounts for other risks is ignored in estimating the cost of equity, and either the Sharpe-Lintner CAPM is used, the Black CAPM is used, or a combination is used, the evidence is that the cost of equity will be understated.

19. Our estimate of the cost of equity using the Black CAPM is presented in Section 5. The cost of equity estimate relies upon an estimate of the zero beta premium of 3.34%, which is based upon historical returns information from 1994 to 2013. The estimation technique for the zero beta premium is described in this report and relies only on stock returns, government bond yields, market capitalisation, book-to-market ratio and industry classifications. Updating the zero beta premium estimate for future periods can be accomplished using the same information, but would expected to change slowly as data is added to the historical information set.

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[5] Stock prices of companies in the same industry move in the same direction, stock prices of companies with similar market capitalisation move in the same direction and stock prices of companies with similar book-to-market ratio move in the same direction.

[6] NERA (2013), Sub-section 5.4, Table 5.3, p. 17. The NERA estimates incorporate an assumption that distributed imputation credits are worth 35 cents in the dollar. NERA also report results that do not assign any value for imputation credits. The corresponding portfolio value excluding any consideration of imputation credits is 9.12%, reported in Sub-section C.1, Table C.3, p. 50. Our analysis does not consider imputation credits, but the NERA comparison demonstrates that including or excluding imputation credits in stock returns did not materially impact upon the estimate of the zero beta premium.

[7] SFG Consulting (2014a).

[8] Fama and French (1993).

2. The development of the Black CAPM

The Sharpe-Lintner CAPM

20. The Sharpe-Lintner CAPM (Sharpe, 1964; Lintner, 1965) is one of a class of asset pricing models under which the required return on equity for a particular asset or firm is determined by adding a premium for risk to the return on a risk-free asset. That is, under these asset pricing models the required return on equity is estimated as the sum of:

    a) The return that investors could obtain on an investment with no exposure to any relevant risk factor; and

    b) A premium for the risk of the asset or firm being evaluated.

21. The various asset pricing models differ according to the way risk is defined and the way the premium for risk is estimated. Under the Sharpe-Lintner CAPM, the premium for risk is estimated in two steps. The first step requires the estimation of the premium that would be required for an asset or firm of average risk, known as the market risk premium. The second step requires the estimation of the risk of the asset or firm in question relative to the average firm or asset. This is known as systematic risk or beta.

22. One of the key assumptions of the Sharpe-Lintner CAPM is that there exists a risk-free asset with a constant fixed return. The return on this asset is known for sure, so is not subject to any risk whatsoever. This risk-free asset is then used as the "investment with no exposure to any relevant risk factor." The Sharpe-Lintner CAPM further assumes that all investors are able to borrow or lend as much as they like at this constant, certain risk-free rate.

23. Given the assumptions of the CAPM, a mathematical proof demonstrates that the required return on equity for any firm must be related to the required return on the market (or average firm) according to the following equation:

$$r_e = r_f + \beta_e \left(r_m - r_f \right)$$

    where:

    a) r_e is the required return on equity for the firm in question;

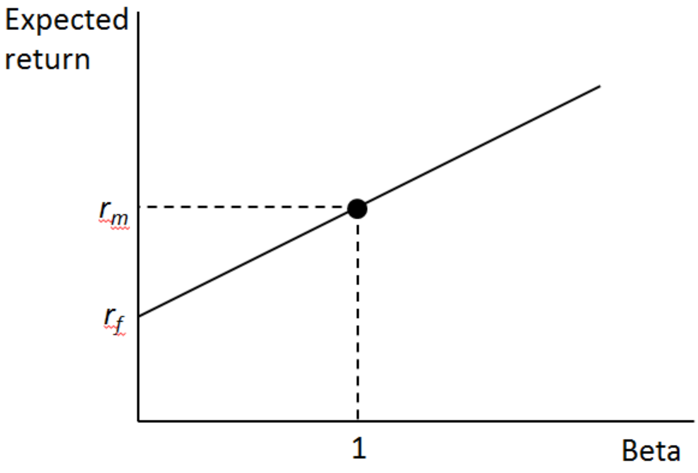
    b) r_f is the return on a risk-free asset;

    c) $(r_m - r_f)$ is the risk premium required for the average firm; and

    d) β_e is the risk of the firm in question relative to the average, also known as the equity beta.

24. This equation is often displayed in graphical form as in Figure 1 below.

Figure 1. Sharpe-Lintner Capital Asset Pricing Model



25. Under the assumptions of the Sharpe-Lintner CAPM, this equation *must* hold as a matter of basic mathematics. If the observed empirical data does not fit the above equation, it must be the case that either:

   a) The assumptions of the CAPM do not hold in practice; and/or

   b) The parameters of the above equation are estimated with error.

The empirical performance of the Sharpe-Lintner CAPM

26. It is well known and generally accepted, on the basis of evidence similar to that detailed below, that the empirical implementation of the Sharpe-Lintner CAPM provides a poor fit to the observed data. That is, when the Sharpe-Lintner CAPM parameters are empirically estimated and inserted into the CAPM formula, the resulting estimate of the required return on equity bears little resemblance to observed stock returns. The feasible implementation of the Sharpe-Lintner CAPM does not fit the observed data.

Black, Jensen and Scholes (1972)

27. A number of empirical tests are based on the following rearranged version of the Sharpe-Lintner CAPM equation:

$$r_e - r_f = (r_m - r_f)\beta_e.$$

28. For example, Black, Jensen and Scholes (1972) construct tests of the model in the form of the following regression specification:[9]

$$r_{e,j} - r_{f,j} = \gamma_0 + \gamma_1 \beta_{e,j} + u_j.$$

29. The Sharpe-Lintner CAPM implies that $\gamma_0 = 0$ and $\gamma_1 = r_m - r_f$. However, a series of studies including Black, Jensen and Scholes (1972) report that the intercept of this regression model is higher

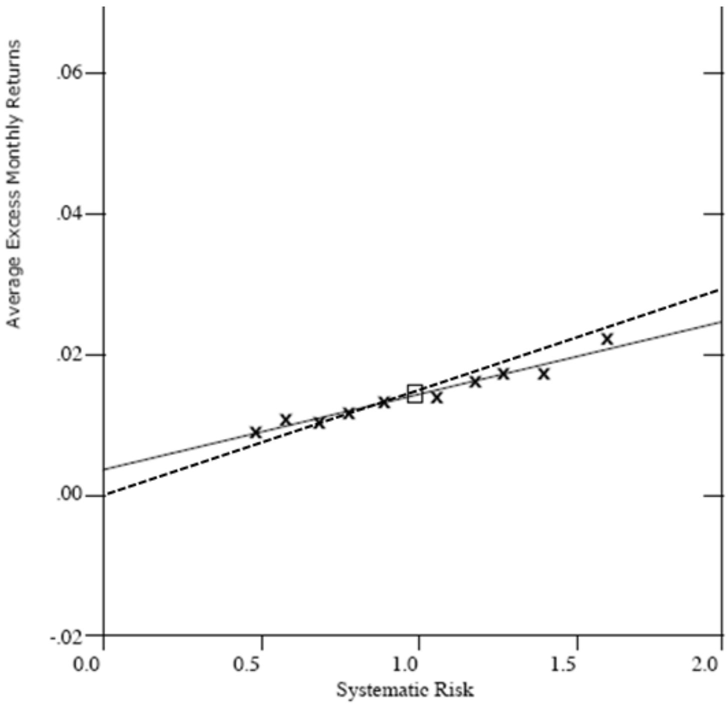
[9] See, for example, Black, Jensen and Scholes (1972), p. 3.

than the Sharpe-Lintner CAPM would suggest $(\gamma_0 > 0)$ and the slope is flatter than the Sharpe-Lintner CAPM would suggest $(\gamma_1 < r_m - r_f)$. For example, Black Jensen and Scholes (1972) state that:

> The tests indicate that the expected excess returns on high beta assets are lower than (1) [the Sharpe-Lintner CAPM equation] suggests and that the expected excess returns on low-beta assets are higher than (1) suggests.[10]

30. The main result of Black, Jensen and Scholes (1972) is summarised in Figure 2 below. In that figure, the dashed line represents the security market line[11] that is implied by the Sharpe-Lintner CAPM and the solid line represents the best fit to the empirical data. The data suggests that the intercept is too high and the slope is too flat to be consistent with the Sharpe-Lintner CAPM.

Figure 2. Results of Black, Jensen and Scholes (1972)



Source: Black, Jensen and Scholes (1972), Figure 1, p. 21. Dashed line for Sharpe-Linter CAPM has been added.

31. Black, Jensen and Scholes (1972) go on to define the intercept of the empirical regression line to be R_z, a quantity that has since become known as the "zero beta premium."[12] They report that the zero beta premium over their sample period of 1931 to 1965 was approximately 4% per year.[13] They go on to conclude that:

[10] Black, Jensen and Scholes (1972), p. 4.

[11] The term "security market line" refers to the linear relationship between beta and expected returns for individual assets or portfolios of assets. In empirical analysis this is typically measured as the line of best fit between beta estimates and realised returns for individual assets or portfolios of assets.

[12] We have not yet described the Black CAPM, but the term "zero beta premium" refers to the difference between the expected return on an asset with zero systematic risk (a zero beta) and the estimate of the risk-free rate (typically estimated as the yield on a government security).

[13] Table 5, p. 38 reports a monthly zero beta premium of 0.338% per month, which is approximately equivalent to 4% per year.

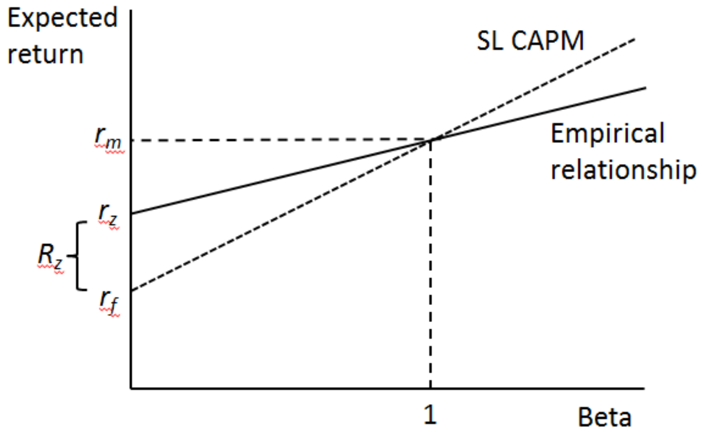
> These results seem to us to be strong evidence favoring rejection of the traditional form of the asset pricing model which says that Rz should be insignificantly different from zero.[14]

and that:

> These results indicate that the usual form of the asset pricing model as given by (1) does not provide an accurate description of the structure of security returns.[15]

32. The empirical relationship and the implications of the Sharpe-Lintner CAPM are contrasted in Figure 3 below. Figure 3 shows the Sharpe-Lintner CAPM in its usual form, whereas in Figure 2 Black, Jensen and Scholes (1972) show excess returns, after subtracting the risk-free rate.

Figure 3. Sharpe-Lintner CAPM vs. empirical relationship.



Friend and Blume (1970)

33. Friend and Blume (1970) define the abnormal return (the Greek letter "eta" or η) to be the observed excess return of a stock (or portfolio) less the expected return from the Sharpe-Lintner CAPM:[16]

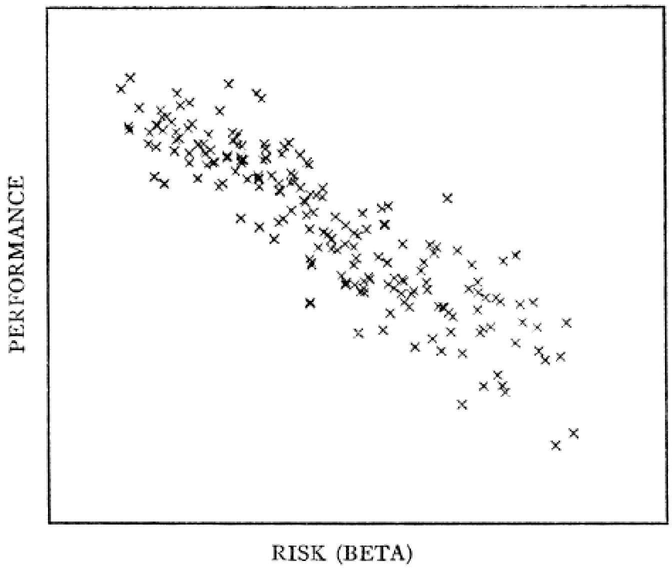
$$\eta_i = (r_e - r_f) - (r_m - r_f)\beta_e .$$

34. Under the Sharpe-Lintner CAPM, η_i should be zero on average and it should be independent of beta. However, Friend and Blume (1970) report a systematic relationship between the abnormal return and beta – *low-beta* stocks generate *higher* returns than the Sharpe-Lintner CAPM would suggest and *high-beta* stocks tend to generate *lower* returns than the Sharpe-Lintner CAPM would suggest. This relationship is shown clearly in Figure 4 below. Friend and Blume note that:

> The absolute values of the performance measures are in excess of market expectations for funds with Beta coefficients below one and below expectations for higher coefficients. [17]

[14] Black, Jensen and Scholes (1972), p. 39.
[15] Black, Jensen and Scholes (1972), pp. 3–4.
[16] Friend and Blume (1970), p. 563.
[17] Friend and Blume (1970), p. 569.

Figure 4. The relationship between abnormal returns and beta



Source: Friend and Blume (1970), p. 567.

35. Friend and Blume (1970) go on to consider what it is about the Sharpe-Lintner CAPM that results in it providing such a poor fit to the observed data. They conclude that the most likely source of the problem is the assumption that all investors can borrow or lend as much as they like at the risk-free rate:

> Of the key assumptions underlying the market theory leading to one-parameter measures of performance, the one which most clearly introduces a bias against risky portfolios is the assumption that the borrowing and lending rates are equal and the same for all investors. Since the borrowing rate for an investor is typically higher than the lending rate, the assumption of equality might be expected to bias the one-parameter measures of performance against risky portfolios because, for such portfolios, investors do not have the same option of increasing their return for given risk by moving from an all stock portfolio to an investment with additional stock financed with borrowings at the lending rate.[18]

Fama and MacBeth (1973)

36. Fama and MacBeth (1973) use the following regression specification:[19]

$$r_{e,j} = \gamma_0 + \gamma_1 \beta_{e,j} + u_j .$$

37. Under this specification, the Sharpe-Lintner CAPM implies that $\gamma_0 = r_f$ and $\gamma_1 = r_m - r_f$. Fama and Macbeth (1973) note that previous empirical work has demonstrated violations of both of these implications of the Sharpe-Lintner CAPM:

[18] Friend and Blume (1970), p. 569.
[19] See Fama and MacBeth (1973), p. 611.

> The work of Friend and Blume (1970) and Black, Jensen, and Scholes (1972) suggests that the S-L hypothesis is not upheld by the data. At least in the post-World War II period, estimates of $E[\tilde{\gamma}_{0t}]$ seem to be significantly greater than R_{ft}.[20]

38. Fama and Macbeth (1973) then test the hypothesis that $\gamma_0 - r_f = 0$ on average. They reject that hypothesis in their data and conclude that:

> Thus, the results in panel A, table 3, support the negative conclusions of Friend and Blume (1970) and Black, Jensen, and Scholes (1972) with respect to the S-L hypothesis.[21]

Fama and French (2004)

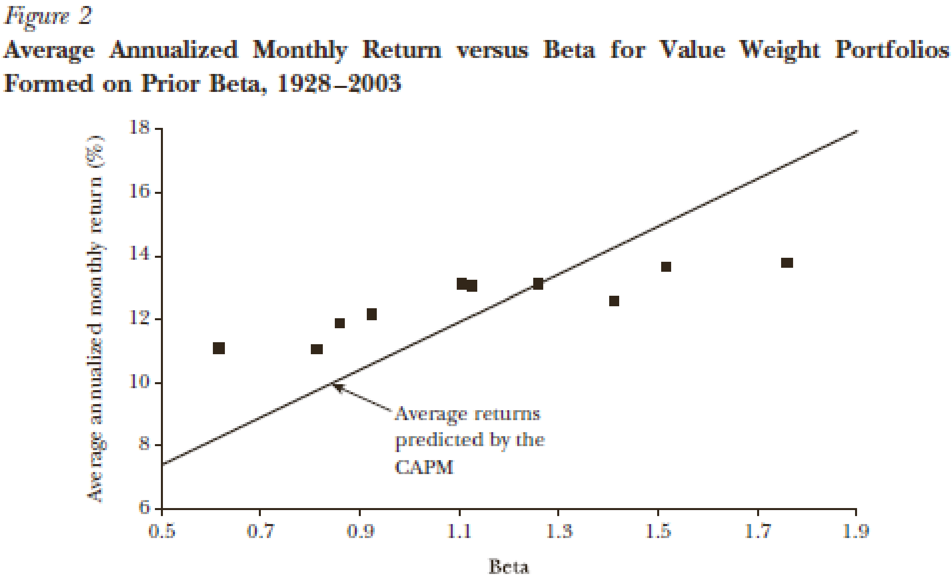
39. The consistent results in the studies reviewed above are not unique to the data from the periods examined in those studies. Rather, the results have proven to be consistent through time – low-beta stocks generate higher returns than the Sharpe-Lintner CAPM would imply and high-beta stocks earn lower returns than the Sharpe-Lintner CAPM would imply. With respect to the early tests of the Sharpe-Lintner CAPM, Fama and French (2004) summarise the state of play as:

> The early tests firmly reject the Sharpe-Lintner version of the CAPM. There is a positive relation between beta and average return, but it is too "flat."

40. Fama and French (2004) then provide an updated example of the evidence using monthly returns on U.S.-listed stocks over 76 years from 1928 to 2003. This analysis is summarised in Figure 5 below. Consistent with the early evidence, realised returns on low-beta stocks are higher than predicted by the Sharpe-Lintner CAPM, and realised returns on high-beta stocks are lower than predicted by the Sharpe-Lintner CAPM. Stocks with the lowest beta estimates (approximately 0.6) had average returns of 11.1% per year, but the Sharpe-Lintner CAPM says the expected return was 8.3% per year. Stocks with the highest beta estimates (approximately 1.8) had average returns of 13.7% per year, but the Sharpe-Lintner CAPM says the expected return was 16.8% per year.

[20] Fama and MacBeth (1973), p. 630.
[21] Fama and MacBeth (1973), p. 632.

Figure 5. Average returns versus beta over an extended time period

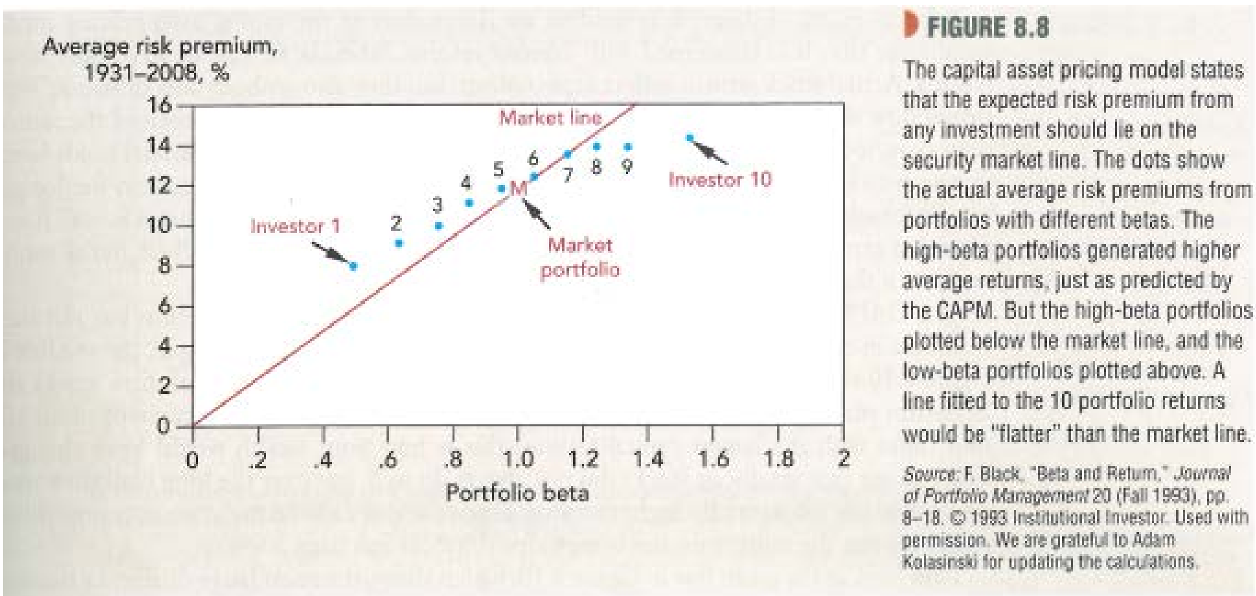


Source: Fama and French (2004), p. 33.

Brealey, Myers and Allen (2011)

41. Brealey, Myers and Allen (2011) extend previous analysis another four years to the end of 2008, and provide a similar chart to that presented by Fama and French (2004), but with excess returns on the vertical axis. This chart is presented below in Figure 6. The line represents the relationship between beta and excess return that is implied by the Sharpe-Lintner CAPM and each dot represents the observed return for a particular portfolio. Clearly, the low-beta portfolios still earn higher returns than the Sharpe-Lintner CAPM would imply.

Figure 6. The relationship between excess returns and beta



Source: Brealey, Myers, and Allen (2011), p. 197.

Summary of empirical evidence

42. The analysis documented above, compiled over four decades of research and using 80 years of stock returns, all reaches the same conclusion. The researchers uniformly reject the Sharpe-Lintner CAPM on the basis that, in the observable data, the relationship between estimated betas and observed stock returns:

a) Has an intercept that is economically and statistically significantly greater than the intercept that is implied by the Sharpe-Lintner CAPM; and

b) Has a slope that is economically and statistically significantly less than the slope that is implied by the Sharpe-Lintner CAPM.

Implications for the CAPM as a theoretical model

43. The empirical rejection of the Sharpe-Lintner CAPM does not disprove it as an economic model for thinking about risk, asset prices and returns. As set out above, under the assumptions of the Sharpe-Lintner CAPM the pricing formula *must* be true as a matter of basic mathematics. That is, given the assumptions of the model, there must be positive linear relationship between equity beta and required returns, exactly as the model suggests. The poor empirical performance of the Sharpe-Lintner CAPM is not due to an error in the logic or in the mathematical derivations. As set out above, the inability of the Sharpe-Lintner CAPM to fit the observed data is because either:

a) The assumptions of the Sharpe-Lintner CAPM do not hold in practice; and/or

b) The parameters of the above equation are estimated with error.

44. One possible reason for the poor empirical performance is that the assumptions of the model may be violated in the real world. If the assumptions do not hold, there is no reason why the pricing formula (which is derived on the basis of those assumptions) would hold. The assumption that all investors can borrow or lend as much as they like at the risk-free rate has been the focus of particular attention in this regard. This has led to the development of the Black (1972) version of the CAPM, whereby that particular assumption has been replaced by the more realistic assumption that investors would have to pay a premium above the risk-free rate when borrowing.[22] The Black CAPM requires that investors can short sell. While in reality investors do not have unlimited ability to sell short, short-selling is a feature of the equity market. The more realistic assumptions of the Black CAPM are a potential reason why this model provides a better fit to the data.

45. By way of another example, the assumption of perfect capital markets (no taxes or transactions costs, symmetric information, no costs associated with financial distress) leads to the implication that stock returns depend on a single factor (market returns). Relaxing that strong assumption leads to multi-factor models. Fama and French (1993) develop one such model wherein stock returns depend on market returns and two additional factors. The Fama-French model has also been shown to provide a materially better fit to the observable data, relative to the Sharpe-Linter CAPM.[23]

46. The other potential explanation for the poor empirical performance of the Sharpe-Lintner CAPM is that we are simply unable to reliably estimate the input parameters. For example, one of the key input parameters is the required return on the market portfolio. The market portfolio is a theoretical

[22] Governments can borrow at close to the theoretical risk-free rate of interest because of taxation powers, but every private investor pays a risk premium according to lenders' perceptions of risk. Of course, even government bond yields are not necessarily equal to the theoretical risk-free rate.

[23] In c companion report, SFG Consulting (2014b), we document the empirical performance of the Fama-French model.

construct consisting of *all* assets that are available to investors. The standard proxy that is used for the market portfolio is the returns on a stock market index, which reflects only a subset of the assets that are available to investors. It is possible that the Sharpe-Lintner CAPM would provide a perfect description of the observed data if only we were able to properly measure the input parameters. In this regard Levy and Roll (2010) note that the empirical implementation of the Sharpe-Lintner CAPM provides a poor fit to observed stock returns. They then look at how much they would have to change the Sharpe-Lintner CAPM input parameters and the observed stock returns to have a reasonable fit between the two. They conclude that it may be the inability to reliably and precisely estimate the various input parameters that is responsible for the poor performance of the Sharpe-Lintner CAPM.

47. This is an interesting theoretical idea, but does nothing to change the fact that the empirical implementation of the Sharpe-Lintner CAPM provides a poor fit to the data. Levy and Roll (2010) can only conclude that the poor performance of the Sharpe-Lintner CAPM may be due to the inability to reliably estimate the parameters – unfortunately, their approach cannot help at all in actually improving the reliability of those parameter estimates. That is, their work provides a potential explanation, rather than a solution, for the poor performance of the model. Consequently, this branch of the literature is of no use to anyone seeking to estimate required returns in practice. The Sharpe-Lintner CAPM, as best as we can estimate it with all of the data and techniques available to us, provides a very poor fit to the observed data. Fama and French (2004) make the same point when they state that:

> this possibility cannot be used to justify the way the CAPM is currently applied. The problem is that applications typically use the same market proxies, like the value-weight portfolio of U.S. stocks, that lead to rejections of the model in empirical tests. The contradictions of the CAPM observed when such proxies are used in tests of the model show up as bad estimates of expected returns in applications ... in short, if a market proxy does not work in tests of the CAPM, it does not work in applications.[24]

The development of the Black CAPM

48. As set out above, the empirical tests of the Sharpe-Lintner CAPM in the 1970's indicated that the relationship between equity beta and stock returns tends to be flatter than the Sharpe-Lintner CAPM would suggest.[25] Black (1972) summarises some of this literature as follows:

[24] Fama and French (2004), pp. 43–44. Fama and French make reference to U.S. data but their point applies equally to Australian data. The empirical performance of the Sharpe-Lintner CAPM is no better using Australian data, as evidenced by the results in the current paper and in the literature covered in our companion report (SFG Consulting, 2014b). Further, we document in our companion report, there is clear evidence that the book-to-market factor is a proxy for a priced risk factor in Australian equity returns.

[25] See, for example, Friend and Blume (1970), Fama and Macbeth (1973) and Black, Jensen and Scholes (1972).

> …several recent studies have suggested that the returns on securities do not behave as the simple capital asset pricing model described above predicts they should. Pratt analyzes the relation between risk and return in common stocks in the 1926-60 period and concludes that high-risk stocks do not give the extra returns that the theory predicts they should give.
>
> Friend and Blume use a cross-sectional regression between risk-adjusted performance and risk for the 1960-68 period and observe that high-risk portfolios seem to have poor performance, while low-risk portfolios have good performance.
>
> …
>
> Black, Jensen, and Scholes analyze the returns on portfolios of stocks at different levels of β_i in the 1926-66 period. They find that the average returns on these portfolios are not consistent with equation (1) [the Sharpe-Lintner CAPM], especially in the postwar period 1946-66. Their estimates of the expected returns on portfolios of stocks at low levels of β_i are consistently higher than predicted by equation (1), and their estimates of the expected returns on portfolios of stocks at high levels of β_i are consistently lower than predicted by equation (1).[26]

49. In trying to develop a conceptual rationale for this observed and consistent empirical finding, Black (1972) states that:

> One possible explanation for these empirical results is that assumption (d) of the capital asset pricing model does not hold. What we will show below is that the relaxation of assumption (d) [all investors can borrow or lend as much as they like at the risk-free rate] can give models that are consistent with the empirical results obtained by Pratt, Friend and Blume, Miller and Scholes, and Black, Jensen and Scholes.[27]

50. That is, Black (1972):

    a) Notes that there is consistent evidence about the empirical failings of the Sharpe-Lintner CAPM; and

    b) Augments the Sharpe-Lintner CAPM to produce a model that does not suffer from those empirical failings; and then

    c) Sets out the conceptual rationale for his augmentation to the Sharpe-Lintner CAPM.

[26] Black (1972), p. 445.
[27] Black (1972), p. 445.

3. The role of the Black CAPM in the AER Guideline

Theoretical considerations

51. In *Better regulation – Rate of return guideline,* (**the Guideline**) the AER states that the Black CAPM will be used to inform the estimate of equity beta.[28] In this regard, the Guideline materials explain that:

> We account for the Black CAPM because we recognise there is merit to its theoretical basis, particularly when viewed alongside the standard Sharpe–Lintner CAPM.[29]

52. The Guideline materials further explain that the Black CAPM has the theoretical merit of relaxing one of the strongest and most unrealistic assumptions of the Sharpe-Lintner CAPM – the assumption that all investors can borrow or lend as much as they like at the risk-free rate:

> The Sharpe–Lintner CAPM assumes there is unlimited risk free borrowing and lending, a simplification that does not hold in practice. The Black CAPM relaxes this assumption and acknowledges that investors may not be able [to] undertake unlimited borrowing or lending at the risk free rate.[30]

53. The Guideline goes on to suggest that the Black CAPM replaces the unrealistic assumption of investors being able to borrow and lend at the risk-free rate with a replacement assumption that is also unrealistic:

> However, in its place the Black CAPM assumes that unlimited short selling[31] of stocks is possible with the proceeds available for investment. This assumption does not hold in practice either, and so there are still concerns over the basis for the model and as a result the empirical estimation of the return on the zero beta portfolio.[32]

54. This assessment of the Black CAPM does not account for an important difference between the Sharpe-Lintner CAPM and the Black CAPM that affects estimation – the Sharpe-Lintner CAPM remains a specific application of the more general model, the Black CAPM. The rationale of the AER is that both models rely upon an assumption that does not hold, so the AER questions why one model is preferable to another. The answer to that question is that the Black CAPM is more general in that it allows flexibility in a parameter input (r_z versus r_f) which gives it some chance of aligning with historical stock returns.

55. Under the assumption that investors can borrow or lend unlimited amounts at the risk-free rate of interest, the more specific Sharpe-Lintner CAPM holds, in which the expected return on a zero beta asset is equal to the risk-free rate. This is a specific model which we know does not align with historical stock returns.

56. Under the assumption that there are no restrictions on short-selling, the more general equation of the Black CAPM holds, in which the zero beta return is not necessarily equal to the risk-free rate of interest. This is a general model which has some chance of aligning with historical stock returns. The historical returns evidence from prior studies considered above all support the use of the Black CAPM over the Sharpe-Lintner CAPM. The issue for corporate finance practice is whether we

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28 AER Guideline, p. 13.
29 AER Explanatory Statement, p. 85.
30 AER Appendix A, p. 17.
31 Short-selling is the practice of borrowing shares from another investor, selling them on the market, and promising to go back into the market some time later to buy back the same number of shares to repay the lender.
32 AER Appendix A, p. 17.

should use a *more* constrained version of the CAPM (the Sharpe-Lintner CAPM, which is inconsistent with empirical evidence with the empirical evidence that low-beta stocks earn higher returns than predicted by the model, and high beta stocks earn lower returns than predicted by the model) or a *less* constrained version of the CAPM (the Black CAPM, which would be aligned more closely with the empirical evidence).

Empirical considerations

57. The Guideline materials note that the Black CAPM requires the estimation of an additional parameter – the zero-beta premium. The Guideline materials conclude that the estimation of the zero-beta premium is "neither simple nor transparent"[33] in which case:

> the estimation of parameters for the Black CAPM is not sufficiently robust such that the model could be implemented in accordance with good practice.[34]

58. The Guideline materials go on to weigh up the advantages of the Black CAPM (the fact that it relaxes the most unrealistic assumption of the Sharpe-Lintner CAPM and provides a better fit to the observed data) against the disadvantage of having to estimate an additional parameter and concludes that the Black CAPM should not be used as the foundation model.[35] The Guideline materials conclude that:

> we propose to use the Black CAPM informatively, rather than mechanistically, because it is difficult to implement it in accordance with good practice.[36]

Using the Black CAPM to inform the estimate of equity beta

59. The equity beta for use in the Black CAPM has the same definition and the same value as the equity beta that is used in the Sharpe-Lintner CAPM. Whichever of these two models is being used to estimate the required return on equity, the same process would be used to estimate the equity beta, as illustrated in Figure 7 below. In that figure, the risk-free rate is 4% and the zero-beta premium is 3%. Consider the case of a stock with an equity beta of 0.4. The Sharpe-Lintner CAPM suggests that the required return on equity is given by:

$$\begin{aligned} r_e &= r_f + \beta(r_m - r_f) \\ &= 4\% + 0.4(10\% - 4\%) = 6.4\% \end{aligned}$$

and the Black CAPM suggests that the required return on equity is given by:

$$\begin{aligned} r_e &= r_z + \beta(r_m - r_z) \\ &= 7\% + 0.4(10\% - 7\%) = 8.2\%. \end{aligned}$$

60. In both cases, beta has the same definition and the same role and the same estimate is used.

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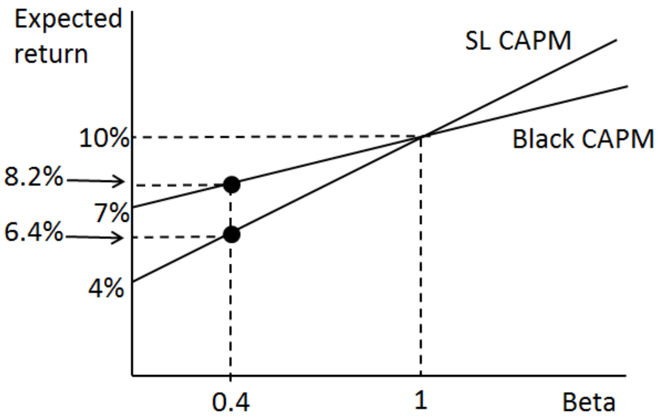
[33] AER Appendix A, p. 16.
[34] AER Appendix A, p. 17.
[35] AER Appendix A, pp. 16–18.
[36] AER Explanatory Statement, p. 85.

Figure 7. Use of beta in the Black CAPM



Source: SFG calculations.

61. The Guideline does not propose to use the Black CAPM to provide an estimate of the required return on equity. Rather, the Guideline proposes to use the Black CAPM to inform the estimate of equity beta that is to be used in the Sharpe-Lintner CAPM foundation model. This is done by considering what estimate of beta would have to be inserted into the Sharpe-Lintner CAPM in order to produce an estimate of the required return on equity equal to that produced by the Black CAPM.

62. In particular, the Guideline materials set out a series of numerical examples of how Sharpe-Lintner beta estimates can be adjusted such that the Sharpe-Lintner CAPM (with the adjusted beta estimate) would produce an estimate of the required return on equity that is commensurate with the Black CAPM. These examples are set out in Appendix C, Table C.11, p. 71.

63. The first row of that table considers a case in which the risk-free rate is 4%, market risk premium is 6%, and zero beta premium is 3%, consistent with the inputs used in Figure 7 above. In this case, the required return on the market is 10%[37] and the intercept for the Black CAPM line is 7%[38] as illustrated in Figure 8 below.

64. Figure 8 also shows that when a beta of 0.4 is inserted into the Sharpe-Lintner CAPM, it produces an estimate of the required return on equity of 6.4%.[39] The Black CAPM suggests that the required return on equity for a firm with beta of 0.4 is 8.2%.[40]

65. We then pose the question: What beta, when inserted into the Sharpe-Lintner CAPM, would produce the Black CAPM estimate of required return of 8.2%? Figure 8 shows that the relevant beta estimate is 0.7. That is, the beta estimate would be revised upwards from 0.4 to 0.7 in order to produce an estimate of the required return on equity that is consistent with the Black CAPM.

66. The logic behind these calculations can be summarised as follows:

    a) Beta is estimated to be 0.4;

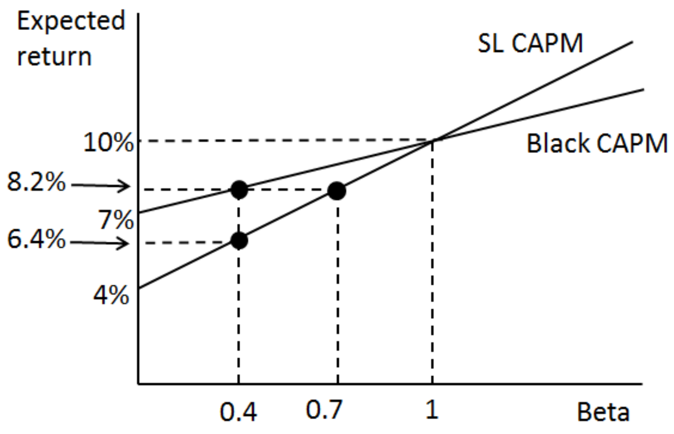
[37] 4% + 6% = 10%.
[38] 4% + 3% = 7%.
[39] 4% + 0.4 × 6% = 6.4%.
[40] The slope of the Black CAPM line is given by (10% – 7%)/(1 – 0) = 3%. Consequently, the required return on equity for a firm with equity beta of 0.4 is 7% + 0.4 × 3% = 8.2%.

b) It is recognised that the theoretical and empirical evidence establishes that if this beta estimate is inserted into the Sharpe-Lintner CAPM, the resulting estimate of the required return on equity (6.4%) will be understated;

c) Inserting the beta estimate of 0.4 into the Black CAPM equation would produce an estimate of the required return on equity of 8.2%;

d) Rather than insert the estimated beta of 0.4 into the Black CAPM, the beta used in the Sharpe-Lintner CAPM is adjusted from 0.4 to 0.7. In the Sharpe-Lintner CAPM, this also produces an estimate of the required return on equity of 8.2%.

Figure 8. AER Black CAPM example



Source: AER Appendix C, Table C.11, Row 1.

67. The Guideline materials then consider a number of different values for the zero beta premium, concluding that a range from 1.5% to 3% appears to be reasonable:

> the size of the zero beta premium is between 150 basis points and 300 basis points (under a variety of scenarios for the risk free rate and market risk premium). This does not seem implausible, since zero beta premiums of this magnitude are below the market risk premium as required by the definition of the Black CAPM. Further, although the borrowing rates for the representative investor are not readily discernible, these magnitudes appear reasonable,[41]

and:

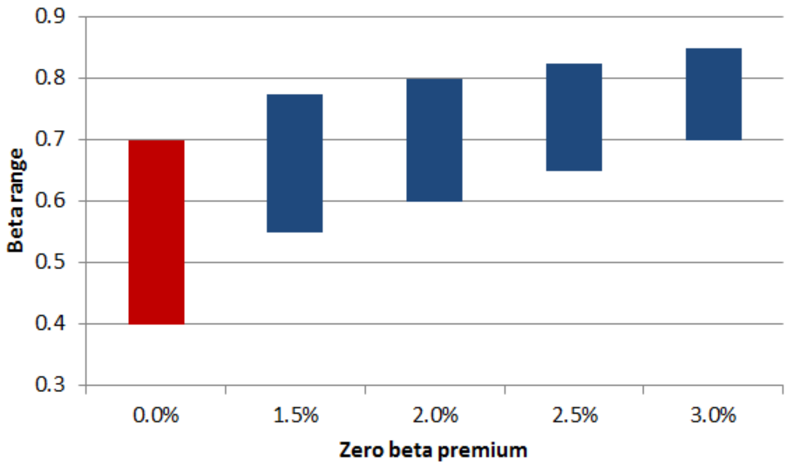
> this magnitude of adjustment appears open to us.[42]

68. In Figure 9 below, the Guideline range for equity beta of 0.4 to 0.7 is displayed in red. The figure then shows the adjusted range for equity beta for different estimates of the Black CAPM zero-beta premium. For example, we have shown above that an equity beta of 0.4 would be adjusted upward to 0.7 if the zero beta premium was set to 3% (i.e., the calculation in the first row of Table C.11 from the Guideline materials). Similarly, a raw beta of 0.7 would be adjusted upward to 0.85. Thus the raw range of 0.4 to 0.7 corresponds to an adjusted range of 0.7 to 0.85.

[41] AER Appendix C, p. 71.
[42] AER Appendix C, p. 71.

69. As discussed below, our view is that the better and more transparent approach is to implement the Black CAPM directly. This involves providing an estimate of the zero-beta premium and using the same beta estimate and the same estimate of the required return on the market that is used for the Sharpe-Lintner CAPM. Such an approach is more direct and transparent than the process of adjusting the estimate of beta that is used in the Sharpe-Lintner CAPM. Our recommended approach requires an estimate of the zero-beta premium – which we address in the remainder of this report.[43]

Figure 9. AER Black CAPM beta ranges



Source: SFG calculations.

[43] In a companion report (SFG Consulting, 2014a) we compile estimates of what the beta input into the AER's foundation model, the Sharpe-Lintner CAPM, would need to be in order to take account of all relevant information. In other words we ask, "If there was a constraint such that the only equation that could be used to estimate the cost of equity was the Sharpe-Lintner CAPM, and if the cost of equity needed to account for all relevant information, what would the beta input need to be?" We maintain that the best approach to estimating the cost of equity is to directly estimate the cost of equity from different models, and assign weights to those models. In the current report on the Black CAPM, we contend that the best way to incorporate this model in the analysis is to make an estimate of the zero beta premium.

4. Estimation of the zero-beta premium

Equations

70. At the outset it is important to note some specific terminology. In the Black CAPM the *zero beta return* (r_z in the equations below) is an estimate of the return on an investment which has zero systematic risk. It takes the place of the risk-free rate in the Sharpe-Lintner CAPM.[44] The *zero beta premium* is the difference between the zero beta return and the risk-free rate ($r_z - r_f$ in the equations below).

71. Our expectation is that the estimate of the zero beta return should lie above the risk-free rate but below the market return (that is, our expectation is that $r_f < r_z < r_m$). However, this expectation will not necessarily be true in sample data for two reasons. First, the proxy for the market portfolio is a portfolio of listed stocks, rather than the entire market. Second, we are measuring realised returns, rather than expectations. Both these reasons leave open the possibility that, in sample data, the estimate of r_z will not necessarily lie between the historical average risk-free rate and the historical average market return.

72. The equation for the Sharpe-Lintner CAPM is as follows:

Expected return on asset *i* = Risk-free rate + Beta of asset *i* × (Expected return on the market – Risk-free rate)

$$r_i = r_f + \beta_i \times (r_m - r_f)$$

73. The equation for the Black CAPM is as follows:

Expected return on asset *i* = Return on the zero beta asset + Beta of asset *i* × (Expected return on the market portfolio – Return on the zero beta asset)

$$r_i = r_z + \beta_i \times (r_m - r_z)$$

Methodology

Introduction

74. Our basic approach is to measure the relationship between realised stock returns, beta and market returns in order to estimate the return on an asset with beta equal to zero. There are two steps to performing this computation.

75. Our first step is to form portfolios. Rather than analyse returns on individual stocks, we analyse returns on portfolios of stocks because we want to minimise the "noise" in historical stock returns. In this context, noise means the difference between realised returns and expectations. Our objective is to measure the *expected* return on a stock with zero beta. But our measurement relies upon realised returns, and these are noisy because some stocks were affected by good news (so had returns above expectations) and some stocks were affected by bad news (so had returns below expectations). In portfolios, the stocks with returns above expectations and below expectations are bundled together so, on average, realised returns should be closer to what we expect.

[44] The difference between the risk-free rate and the return on a zero beta asset is that the risk-free rate does not contain any risk exposure, whereas the zero beta asset has zero systematic risk exposure. The zero beta asset could still have risks that are not systematic, but these non-systematic risks do not affect the price of the zero beta asset in the Black CAPM.

76. The portfolios are formed in a particular way, in order to minimise noise – the portfolios are formed so each portfolio has similar industry, size and book-to-market characteristics. This objective is to maximise the difference in beta estimates across portfolios, but minimise the difference of other characteristics likely to affect stock returns.

77. The second step is to perform a regression of portfolio returns every four weeks on two independent variables – beta × market returns and (1 – beta). As we show with some algebra, the coefficient on the second independent variable (1 – beta) is an estimate of the zero beta return. To estimate the zero beta premium, we subtract the average four-weekly risk-free rate over the sample period, measured as the yield to maturity on 10-year government bonds.

Minimising noise in realised returns

78. As mentioned above, in estimating the zero beta return from historical stock returns the objective is to minimise noise in the data as much as possible. Most noise results from the fact that we are estimating a parameter of a model of *expected* returns, using data from *realised* returns. Realised returns are noisy in the sense that stock returns are affected by company- and industry-specific events, so realised returns differ from what is expected. This noise affects estimation in two ways.

    a) Beta estimates are affected by noise. The historical relationship between stock returns and market returns may not represent the expected relationship between stock returns and market returns.

    b) The level of stock returns is affected by noise. The equations above state that the expected return on stocks increases in direct proportion to their beta estimates. On an individual stock level, realised returns will be far from expectations, with some stocks earning returns well above expectations and some stocks earning returns well below expectations.

79. Given the noise inherent in realised stock returns we need to minimise estimation error to the greatest extent possible. This means minimising noise in beta estimates, and minimising noise in the level of stock returns.

Beta estimation for individual stocks

80. The first step of our analysis is to compile beta estimates for individual stocks. Every four weeks from 19 January 1994 to 22 January 2014 we compile a beta estimate for each stock for which a large amount of data is available for analysis, as explained below. Each stock's beta estimate is compiled by regressing four-weekly stock returns on four-weekly market returns using all available returns information prior to a portfolio formation date. For example, 19 January 1994 is the first portfolio formation date. So any stock in a portfolio on this date has a beta estimate compiled from all available stock returns ending on 19 January 1994. The market return is a market capitalisation weighted average of returns on sample firms, to ensure the results are not distorted by any difference between the compilation of a market index and the firms with returns available for analysis.

81. The four-weekly returns used to estimate beta are compiled on every single trading day in the beta estimation period. For example, there is a four-weekly period from 30 December 1993 to 19 January 1994, a four-weekly period from 29 December 1993 to 18 January 1994, and so on. This means that all daily stock closing prices are used in beta estimation.

82. For inclusion in a portfolio we require a stock to have at least 2,520 four-weekly returns available for analysis, which represents 10 years of returns. We only include returns for which there is positive volume recorded on the day, to ensure that a trade actually occurred on that day.

83. The initial sample comprised all listed stocks, and de-listed stocks, with a primary quote on the Australian Securities Exchange. To be included in the final sample we required a beta estimate that met the above criteria, along with information on market capitalisation, book value of equity and industry according to the International Classification Benchmark (ICB). Data was sourced from Datastream.

84. The final sample comprises 49,421 beta estimates formed over 258 four-weekly periods from 19 January 1994 to 22 January 2014. The average beta estimate is 1.07, the median beta estimate is 1.00 and the standard deviation of beta estimates is 0.42.[45] The number of sample stocks increases from 20 in the first four-weekly period to a maximum of 416 on 12 June 2013. On average, 191 stocks have beta estimates each four-weekly period.

Portfolio formation

85. The rationale for analysing portfolios is to minimise the impact of company- and industry-specific noise on returns. The objective is to form portfolios with the maximum difference in beta estimates across portfolios, but with minimum difference on other dimensions associated with stock returns. In other words we want to measure the relationship between stock returns, beta and market returns across portfolios that only differ in terms of their beta estimates. In order to achieve this objective we form portfolios in the following manner. Ultimately, in each four-week period, we have portfolios of high, medium and low beta stocks that have approximately the same composition in terms of size, book-to-market ratio and industry composition.

86. First, we classify stocks as big market capitalisation or small market capitalisation using the following criteria used by Brailsford, Gaunt and O'Brien (2012a, 1012b). After ranking stocks from largest to smallest market capitalisation, big stocks are those that comprise the largest 90% of stocks on aggregate market capitalisation and small stocks are those that comprise the smallest 10% of stocks on aggregate market capitalisation. According to this criteria, 21% of observations are classified as big stocks and 79% of stocks are classified as small stocks. It is important to point out that we do not form portfolios of big stocks and portfolios of small stocks. The objective is to form portfolios that include some big stocks and some small stocks, but which differ according only to beta estimates.

87. Second, we classify stocks as high, medium or low book-to-market ratio, again using the criteria used by Brailsford, Gaunt and O'Brien (2012a, 2012b). In each four-week period from 19 January 1994 to 22 January 2014 we compile the book-to-market ratio of stocks at the 30th and 70th percentiles of the largest 200 stocks by market capitalisation. Stocks with a book-to-market ratio above the 70th percentile are classified as high book-to-market stocks, stocks with a book-to-market ratio below the 30th percentile are classified as low book-to-market stocks, and the remaining stocks are classified as medium book-to-market stocks. According to these criteria, 30% of observations are ultimately classified as low book-to-market stocks, 37% of observations are classified as medium book-to-market stocks and 33% of observations are classified as high book-to-market stocks. As mentioned with respect to the size decomposition, we do not form portfolios of high, medium and low book-to-market stocks. Rather, this decomposition will be used to form portfolios of high, medium and low beta stocks that have approximately the same book-to-market ratio, but which differ according to beta estimates.

[45] The average beta estimate of 1.07 is an equal-weighted average of beta estimates for all sample firms across all time periods. If the market portfolio is constructed from sample firms, and weights in the market portfolio are held constant, the market capitalisation weighted average beta estimate will equal exactly one.

Table 1. Average beta estimates and number of observations according to size, book-to-market and industry partitions

Panel A: Average beta estimates

	Small			Big								
	Low B/M	Med B/M	High B/M	Low B/M	Med B/M	High B/M	Small	Big	Low B/M	Med B/M	High B/M	All
Oil & gas	1.37	1.30	1.19	1.00	0.86	0.85	1.27	0.92	1.28	1.22	1.18	**1.22**
Basic materials	1.27	1.28	1.29	1.20	1.18	1.29	1.28	1.20	1.26	1.27	1.29	**1.27**
Industrials	1.06	0.91	0.86	0.94	0.89	0.95	0.92	0.92	1.01	0.91	0.87	**0.92**
Consumer goods	0.74	0.85	0.86	0.74	0.74	0.78	0.83	0.75	0.74	0.84	0.86	**0.81**
Health care	1.10	0.96	1.11	0.71	0.86	0.86	1.06	0.78	1.03	0.93	1.08	**1.00**
Consumer services	1.02	0.84	0.96	0.80	0.84	1.00	0.94	0.85	0.93	0.84	0.97	**0.91**
Telecommunications	1.61	1.47	1.24	0.86	.	.	1.40	0.86	1.20	1.47	1.24	**1.29**
Utilities	1.11	0.84	1.08	.	0.84	0.83	0.94	0.84	1.11	0.84	0.97	**0.90**
Financials	0.94	0.73	0.85	0.88	0.92	0.69	0.83	0.84	0.92	0.85	0.80	**0.83**
Technology	1.20	1.31	1.21	.	.	.	1.24		1.20	1.31	1.21	**1.24**
All	**1.16**	**1.10**	**1.07**	**0.96**	**0.93**	**0.81**	**1.11**	**0.92**	**1.11**	**1.05**	**1.04**	1.07

Panel B: Number of observations

	Small			Big								
	Low B/M	Med B/M	High B/M	Low B/M	Med B/M	High B/M	Small	Big	Low B/M	Med B/M	High B/M	All
Oil & gas	946	1636	1851	318	359	106	4433	783	1264	1995	1957	**5216**
Basic materials	4241	5222	4929	1132	761	150	14392	2043	5373	5983	5079	**16435**
Industrials	1149	1966	2232	785	569	143	5347	1497	1934	2535	2375	**6844**
Consumer goods	831	1131	1216	309	185	57	3178	551	1140	1316	1273	**3729**
Health care	1329	590	289	291	240	40	2208	571	1620	830	329	**2779**
Consumer services	898	1056	1063	573	556	189	3017	1318	1471	1612	1252	**4335**
Telecommunications	72	127	146	87	.	.	345	87	159	127	146	**432**
Utilities	32	294	167	.	194	126	493	320	32	488	293	**813**
Financials	443	1043	2187	369	1770	1067	3673	3206	812	2813	3254	**6879**
Technology	776	587	416	.	.	.	1779		776	587	416	**1779**
All	**10717**	**13652**	**14496**	**3864**	**4634**	**1878**	**38865**	**10376**	**14581**	**18286**	**16374**	**49241**

88. The table above presents the number of observations, and the average beta estimate, of stocks formed from the intersection of size, book-to-market and industry partitions.

a) On average, small stocks have higher beta estimates than large stocks (1.11 versus 0.92). The result that small stocks have higher beta estimates than large stocks occurs in eight of nine industries, and across the spectrum of high, medium and low beta stocks. So if we were to form portfolios of stocks according to beta estimates, and without ensuring those portfolios had stocks of similar size, we risk introducing noise into the analysis if small stocks earn different returns to large stocks.

b) Some industries have higher average beta estimates than others, ranging from 0.81 for consumer goods to 1.29 for telecommunications. So if we were to form portfolios of stocks according to beta estimates, without ensuring those portfolios had a similar industry composition, we risk introducing noise into the analysis if some industries earn returns above expectations, and some industries earn returns below expectations.

c) Finally, low book-to-market stocks have higher average beta estimates than high book-to-market stocks, although this is not consistent across industries. By the same rationale as with size and industry, we want to ensure that our portfolios of high, medium and low beta stocks are similar in terms of book-to-market ratio.

89. Having partitioned observations into cohorts according to industry, size and book-to-market ratio each period we classify each observation in a cohort as a high, medium or low beta stock, depending upon whether its beta estimate is in the top third, middle third or bottom third. We repeat this allocation for all 258 four week periods starting from 19 January 1994 and ending 22 January 2014.

Portfolio characteristics and average returns

90. In Table 2 we summarise the characteristics of portfolios formed according to high, medium and low beta estimates. The portfolios are weighted by market capitalisation in order to maximise diversification. So the table presents the market capitalisation weighted beta estimates, book-to-market ratio, and stock returns, averaged across each of the 258 four-week periods. It also presents the average market capitalisation of portfolio stocks and the market weight in each industry within each portfolio across the 258 four-week periods. The information presented in the table confirms that each portfolio has approximately the same characteristics in terms of size, book-to-market ratio and industry composition.

91. The table also shows that, on average across the four-week periods, high beta stocks earned higher returns than low beta stocks. The high beta portfolio, with an average portfolio beta of 1.13, earned average four-weekly returns of 0.86%. This is equivalent to returns of 11.86% per year.[46] In contrast, the portfolio of low beta stocks, with an average portfolio beta of 0.80, earned average four-weekly returns of 0.76%. This is equivalent to returns of 10.37% per year.[47]

92. However, the portfolio of medium beta stocks earned the highest average returns across the four-week periods of 1.00%. This is equivalent to returns of 13.89% per year.[48] The overall average return across four-week periods is 0.87%, equivalent to 12.03% per year.[49] So the average return on medium beta stocks is too high to be consistent with the CAPM, and the average return on high beta stocks is too low to be consistent with the CAPM.

93. One reason why the returns on medium beta stocks are not consistent with the CAPM predictions is that this is an average result over 20 years that does not account for differences in market returns over time. For example, suppose in one four-week period the market earned a return of –18%.[50] High beta stocks would be expected to earn very negative returns in this period, and low beta stocks would be expected to earn less negative returns in this period. If we happen to observe a sample period in which the market performed poorly, there is no reason to expect high beta stocks to earn higher returns than low beta stocks for that period. We would expect high beta stocks to perform worse than low beta stocks. In contrast, suppose that in another four-week period the market earned a return of 11%.[51] High beta stocks would be expected to outperform low beta stocks in this period. If we happen to observe a sample period in which the market performed well, we would expect high beta stocks to earn higher returns than low beta stocks. That is, expected returns are conditional on market performance.

[46] Annual returns are computed as $(1 + 0.0086)^{365.25/28} - 1 = 0.1186$.
[47] Annual returns are computed as $(1 + 0.0076)^{365.25/28} - 1 = 0.1037$.
[48] Annual returns are computed as $(1 + 0.0100)^{365.25/28} - 1 = 0.1389$.
[49] Annual returns are computed as $(1 + 0.0087)^{365.25/28} - 1 = 0.1203$.
[50] This is, in fact, the minimum four-week market return in our sample.
[51] This is, in fact, the maximum four-week market return in out sample.

Table 2. Average portfolio characteristics across four-week periods

	Low beta	Medium beta	High beta	All portfolios
Market value-weighted beta estimate[52]	0.80	0.93	1.13	0.95
Market value-weighted stock return (%)	0.76	1.00	0.86	0.87
Annualised equivalent returns (%)	10.37	13.89	11.86	12.03
Mkt val. stk. ret. in low ret. periods (%)	-2.60	-2.62	-2.97	-2.73
Mkt val. stk. ret. in high ret. periods (%)	3.34	3.78	3.80	3.64
Average market capitalisation ($m)	3472	3567	2545	3195
Market value-weighted book-to-market	0.49	0.50	0.52	0.50
Industry weight (%):				
Oil & gas	3.6	9.1	4.1	5.7
Basic materials	32.1	20.3	30.2	27.5
Industrials	7.7	10.2	7.6	8.5
Consumer goods	2.8	4.9	4.5	4.1
Health care	2.3	3.0	4.7	3.3
Consumer services	14.4	8.0	11.0	10.9
Telecommunications	2.3	4.5	0.5	3.1
Utilities	1.2	3.2	2.4	2.5
Financials	39.5	39.1	39.4	39.3
Technology	0.2	0.1	0.2	0.2

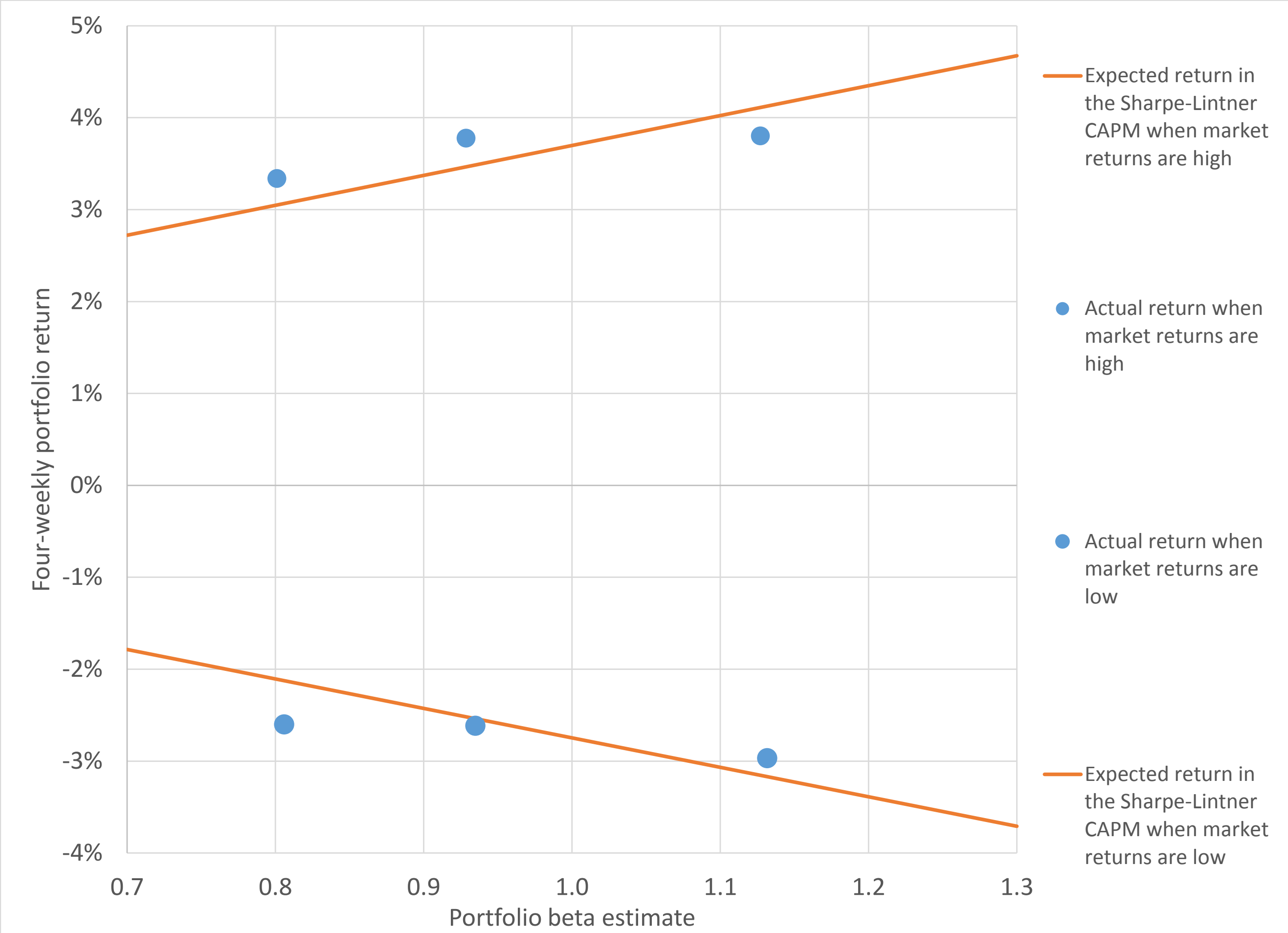
94. This is just what we observe across the 258 four-week returns periods in the sample. During periods in which market returns were high, returns across the portfolios increased as we moved from low beta to medium beta and then high beta portfolios. During periods in which market returns were low, the high beta portfolio earned the lowest returns, followed by the medium beta portfolio and then the low beta portfolio. Specifically, we disaggregated the 258 periods into 112 periods of low returns (in which the four-week return was less than 0.6880%); and 146 periods of high returns (in which the four-week return was at least equal to 0.6880%).[53] In the table above we present average portfolio returns for these two sub-samples. During periods in which market returns were high, average returns to low, medium and high beta portfolios were 3.34%, 3.78% and 3.80%, respectively. During periods in which market returns were low, average returns to low, medium and high beta portfolios were –2.60%, –2.62% and –2.97%, respectively.

95. This relationship between beta estimates and portfolio returns during periods of different market returns is illustrated in Figure 10. When market returns are high, portfolio returns increase as beta increases, and when market returns are negative, portfolio returns decrease as beta increases. This is directionally consistent with the Black CAPM and the Sharpe-Lintner CAPM. But the slope of the relationship between beta estimates and portfolio returns is less steep than predicted by the Sharpe-Lintner CAPM. The orange line shows what return would have been expected across the portfolios is the Sharpe-Lintner CAPM described portfolio returns.

[52] The reason the market capitalisation weighted beta estimate is not exactly equal to one is that the weight of each stock in the market portfolio varies each month due to change in market capitalisation. The market capitalisation weighted beta estimate will only be precisely equal to one if the weights are constant.

[53] The cut-off of 0.6880% is our estimate of the zero beta return, presented subsequently. But in this section our intention is to demonstrate that in periods in which the market return is high there is a positive association between beta estimates and portfolio returns and in periods when the market return is low there is a negative association between beta estimates and stock returns. The conclusion is the same if we use a cut-off of 0.9002% (the average four-week return in our sample), a cut-off of 0.4489% (the average yield to maturity on 10-year government bonds), or the yield to maturity on 10 year government bonds in the particular four-week period.

Figure 10. Beta estimates and portfolio returns across high versus low market returns



96. The figure shows that, when the market earns high returns, low beta stocks perform better than predicted by the Sharpe-Lintner CAPM; and when the market earns low returns, low beta stocks perform worse than predicted by the Sharpe-Lintner CAPM. To use a term often used by financial market practitioners, low beta stocks are meant to be *defensive stocks* offering less exposure to market returns than high beta stocks. But they are not as defensive as predicted by the Sharpe-Lintner CAPM.

97. In the following sub-section we quantify the relationship between realised portfolio returns, market returns and beta, ultimately arriving at an estimate of the zero beta premium. The estimate of the zero beta premium is the mechanism via which we can implement the actual relationship between systematic risk and stock returns, and not the assumed relationship implied by the Sharpe-Lintner CAPM.

Estimate of the zero beta return

Regression analysis

98. Recall that the equation for the Black CAPM is as follows:

$$r_i = r_z + \beta_i \times (r_m - r_z)$$

99. The equation can be re-arranged so that the expected return on asset i is the sum of $(1 - \beta_i) \times r_z$ and $\beta_i \times r_m$ as shown below:

$$r_i = r_z + \beta_i \times r_m - \beta_i \times r_z$$

$$r_i = (1 - \beta_i) \times r_z + \beta_i \times r_m$$

100. Our objective is to estimate r_z from our sample of 774 portfolio returns (3 portfolios × 258 periods = 774 portfolio observations). So we perform a regression of portfolio returns on two independent variables, namely (1 – portfolio beta) and (portfolio beta × the market return). Formally, the regression equation is as follows:

$$r_{i,t} = \gamma_0 + \gamma_1 \times (1 - \beta_{i,t}) + \gamma_2 \times (\beta_{i,t} \times r_{m,t}) + \varepsilon_{i,t}$$

where $r_{i,t}$ is the return to portfolio i in period t, $r_{m,t}$ is the market return in period t, $\beta_{i,t}$ is the beta estimate for portfolio i in period t estimated using returns prior to period t, and $\varepsilon_{i,t}$ is an error term relating to portfolio i in period t.[54]

101. In this equation, the coefficient γ_1 is the estimate of the return on a zero beta portfolio. The results of performing this regression are presented in Panel A of the table below. In subsequent panels we present results under alterative specifications of the regression equation.

102. The estimate of the return on the zero beta portfolio is 0.6880% over four weeks. This represents an annualised return of 9.36%.[55] By way of comparison, over the sample period the average yield to maturity on 10-year government bonds was 0.449% (6.02% per year) and the average market return was 0.900% (12.40% per year). So the estimated return on the zero beta asset lies between the normal estimate of the risk-free rate of interest and the average market return. The zero beta premium (the difference between the zero beta return and the estimate of the risk-free rate) is estimated at 0.239% over four weeks[56] or 3.34% per year.[57]

103. There are alternative ways we could have written the regression equation. One approach would have been to measure the independent variable as portfolio returns minus beta × market return. This effectively constrains the coefficient γ_2 to equal one. The results of this alternative regression specification are presented in Panel B. This alternative regression specification has no material impact on the results because the γ_2 coefficient in the unconstrained regression (1.026) was close to one. In this alternative case, the zero beta return is estimated at 0.677% over four weeks (9.20% per year).

104. An additional constraint we could have imposed on the analysis would have been to constrain the intercept to equal zero. Results from imposing this additional constraint are presented in Panel C. Under this alterative specification, the zero beta return is estimated at 0.666% over four weeks (9.04% per year).

[54] Readers will note that beta appears in two independent variables in the regression. However, this does not present a multicollinearity problem because the market return varies each four-week period. Across the 774 portfolios the correlation between the two independent variables is –0.02.
[55] Annual returns are computed as $(1 + 0.00688)^{365.25/28} - 1 = 9.36\%$.
[56] That is (over four weeks), $r_z - r_f = 0.00688 - 0.00449 = 0.239\%$.
[57] That is (annualised returns), $r_z - r_f = 0.0936 - 0.0602 = 3.34\%$.

Table 3. Estimation of the return on a zero beta asset

Coefficient	Estimate	Standard error	90% confidence interval
Panel A: Unconstrained regression			
γ_0	−0.029%	0.065%	−0.14% to 0.08%
γ_1	0.688%	0.389%	0.05% to 1.33%
γ_2	1.026	0.015	1.00 to 1.05
R-squared	85.16%		
Panel B: Returns relative to beta × market return			
γ_0	−0.027%	0.063%	−0.11% to 0.10%
γ_1	0.677%	0.390%	0.03% to 1.32%
R-squared	0.39%		
Panel C: Returns relative to beta × market return and intercept constrained to zero			
γ_1	0.666%	0.374%	0.05% to 1.28%
R-squared[58]	0.41%		
Panel D: Zero beta premium relative to the time-varying government bond yield			
γ_0	−0.027%	0.065%	−0.14% to 0.08%
γ_1	0.238%	0.389%	−0.40% to 0.88%
γ_2	1.026	0.015	1.00 to 1.05
R-squared	85.16%		

106. A final set of results presented in the table is for the case in which we estimate the zero beta premium in the regression, rather than estimating the zero beta return and subtracting the average risk-free rate. The reason we initially estimated the zero beta return is because we did not want our estimates to be impacted by the variation in the government bond yields over time. Government bond yield do not vary substantially from one day to the next, but over the course of our sample period varied from 2.86% to 10.70% per year. We did not want a proxy for the risk-free rate to impact upon the estimate of the zero beta return from the regression.

107. However, under the alternative specification in which we estimate the zero beta premium, the results to do vary in a material way. The regression equation is presented below and the results are presented in Panel D.

$$r_{i,t} = \gamma_0 + \gamma_1 \times (1 - \beta_{i,t}) + \gamma_2 \times [r_{f,t} + \beta_{i,t} \times (r_{m,t} - r_{f,t})] + \varepsilon_{i,t}$$

108. The zero beta premium is estimated at 0.238% over four weeks. On average, this represents a zero beta return of 0.687% over four weeks (9.34% per year) after adding the average risk-free rate of 0.449% over four weeks (6.02% per year). The zero beta premium on an annualised basis is then 3.32%.[59]

109. The other coefficients (γ_0 and γ_2) should be interpreted jointly with the zero beta premium. The intercept of –0.029% and the coefficient of 1.026 on beta × market return mean that, if the market earns a return of 1% during a four week period and a stock has a beta estimate of 0.7, that stock would be predicted to earn a return of 0.895%. The predicted return is –0.029% + 0.688% × (1 – 0.7) + 1.026 × 1.000% = –0.029% + 0.206% + 0.718% = 0.895%. In contrast, the corresponding return for a stock with a beta estimate of 1.0 is 0.997%. So the difference in predicted returns between the stock with a beta estimate of 0.7 and a beta estimate of 1.0 is 0.101%. In contrast, in the

[58] Note that it is not appropriate to compared to the R-squared from a constrained regression to the R-squared from an unconstrained regression.

[59] The four-week zero beta premium is estimated at 0.238%. $r_z = r_f + (r_z - r_f)$ = 0.449% + 0.238% = 0.687%. On an annualised basis, $r_z = (1.00687)^{365.25/28} - 1$ = 9.34%, and $r_f = (1.00449)^{365.25/28} - 1$ = 6.02%, and $r_z - r_f$ = 934% – 6.02% = 3.32%.

Sharpe-Linter CAPM, the difference in predicted returns between the two stocks would be 0.165% over four weeks.[60]

Results if portfolios are formed only with regard to beta estimates

110. Recall that we formed portfolios in a manner that ensured that high, medium and low beta portfolios had similar characteristics in terms of industry, size and book-to-market ratio. This means that our estimate of the zero beta premium can only be used to estimate the cost of equity if industry, size and the book-to-market ratio do not matter for expected returns.

111. Put another way, if we were to estimate the cost of equity for a firm with neutral exposure to risks associated with industry, size and the book-to-market ratio (the firm is no more or less risky than the average firm in the market on these dimensions), we could use the Black CAPM with a zero beta premium of 3.34%. But if a firm had different overall risk exposure to the average firm on the basis of risks not captured by beta, the cost of equity from the Black CAPM would ignore a material component of risk.

112. Consider the following example, suppose the risk-free rate was 4.12%, the market risk premium was 6.50%, a firm had beta estimate of 0.7 and the firm was no more or less risky than other firms in the market on the basis of its industry, size or book-to-market ratio. The Sharpe-Lintner CAPM would imply a cost of equity of 8.67%.[61] This would understate the cost of equity because low beta stocks earn higher returns than implied the Sharpe-Lintner CAPM. The Black CAPM can then be used to estimate the cost of equity of 9.67%.[62]

113. In contrast, if the firm has positive exposure to risks that were not accounted for in the beta estimate, the Black CAPM estimate of 9.67% would understate the cost of equity. The zero beta premium estimate of 3.34% is not a catch-all figure to account for all the reasons why some stocks earn higher returns than other stocks. It is an input into the Black CAPM to *adjust the beta component of the required return only*. The zero beta premium of 3.34% cannot account for risks not associated with beta because it was estimated on the basis *only* on the differences in beta across portfolios.

114. The AER was previously presented with a suite of zero beta premium estimates from NERA Economic Consulting (2013) which exceeded estimates of the market risk premium.[63] The NERA zero beta premium estimates are uniformly higher than our cost of equity estimates, even when considered across the period 1994 to 2012, which almost matches our sample period of 1994 to 2013.[64] Based upon NERA's full sample of 39 years of returns from 1974 to 2012, the range of zero beta premium estimates from these four sets of analysis is from 8.74% year to 13.95% per year.[65]

115. The reason our point estimate of the zero beta premium is lower than the AER's market risk premium estimate of 6.5%, and NERA's (2013) estimates are higher than the AER's market risk

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[60] This calculation assumes a risk-free rate of 0.449% over four weeks, so the difference between the market return and the risk-free rate = 1.000% – 0.449% = 0.551%. If the beta estimates differ by 0.3 the difference in predicted returns in the Sharpe-Lintner CAPM is 0.3 × 0.551% = 0.165%.

[61] In the Sharpe-Lintner CAPM, $r_e = r_f + \beta_e \times (r_m - r_f) = 0.0412 + 0.7 \times (0.1062 - 0.0412) = 0.0412 + 0.0455 = 8.67\%$.

[62] In the Black CAPM, $r_e = r_z + \beta_e \times (r_m - r_z) = (0.0412 + 0.0334) + 0.7 \times (0.1062 - 0.0746) = 0.0746 + 0.0221 = 9.67\%$.

[63] The results of the NERA study are consistent with the results presented to the AER five years prior by CEG (2008). In the CEG study of Australian stock returns from 1974 to 2007, estimates of the zero beta premium exceeded 7% per year so were above typical estimates of the market risk premium of around 6.0% to 6.5%.

[64] The NERA sample extends from 1979 to 2012. We cannot compile analysis using this same time period because we require information on the book-to-market ratio, and we rely upon at least 10 years of returns information to estimate beta (NERA relies upon five years).

[65] NERA (2013), Sub-section 5.2, Table 5.2, p. 16, and Sub-section 5.5, Table 5.6, p. 23. This is the range of the four point estimates. It does not represent the ranges around those point estimates.

premium estimate is as follows. The portfolios relied upon by NERA do not necessarily have the same industry, size and book-to-market ratio. The portfolios are formed only on the basis of beta estimates. So differences in returns across portfolios will be, in part, due to differences in risks associated with industry, size and book-to-market ratio.

116. To examine this conjecture, we repeated our analysis after forming portfolios only on the basis of beta estimates. Recall that in our sample, beta estimates were higher for small firms compared to large firms, higher for low book-to-market firms compared to high book-to-market firms, and varied across industry. Results are presented in Table 4.

117. Under this alternative portfolio composition, the estimate of the zero beta return is 1.097% over four weeks (15.29% per year) as shown in Panel A. In comparison to the average yield on 20-year government bonds over the sample period (0.449%), this is a zero beta premium of 0.648% over four weeks and 9.28% per year.[66] As shown in Panels B, C and D there is no material change in the estimates of the zero beta return and the zero beta premium under alternative regression specifications.

118. The zero beta premium estimate of 9.28% per year can be compared to the figure of 9.12% reported by NERA (2013).[67] This is the zero beta premium estimate formed from portfolios over a time period which is one year different to the time period we analyse (1994 to 2012 for NERA and 1994 to 2013 in our sample). The standard errors of the zero beta premium are also similar (4.20% per year in our sample compared to 4.69% per year reported by NERA).[68] So when portfolios are constructed using only beta estimates there is a high degree of correspondence in the estimate of the zero beta premium across the two sets of analysis.

[66] The annualised zero beta return = $(1.01097)^{(365.25/28)} - 1$ = 15.29%, the annualised yield on 10-year government bonds = $(1.00449)^{(365.25/28)} - 1$ = 6.02%, so the annualised zero beta premium = 15.29% – 6.02% = 9.28%.

[67] NERA (2013), Sub-section C.3, Table C.3, under Portfolios, 1994 to 2012. This is also the NERA estimate that does not include any value for imputation credits in stock returns.

[68] The annualised standard error of the zero beta return is computed as $(365.25 \div 28) \times (1.0197)^{(365.25/28 - 1)} \times 0.00282$ = 4.20% using the delta method recommended by NERA.

Table 4. Estimation of the return on a zero beta asset after forming portfolios only with respect to beta

Coefficient	Estimate	Standard error	90% confidence interval
Panel A: Unconstrained regression			
γ_0	−0.019%	0.090%	−0.17% to 0.13%
γ_1	1.097%	0.282%	0.63% to 1.56%
γ_2	1.031	0.0204	1.00 to 1.06
R-squared	76.81%		
Panel B: Returns relative to beta × market return			
γ_0	0.009%	0.088%	−0.14% to 0.15%
γ_1	1.072%	0.282%	0.61% to 1.54%
R-squared	1.84%		
Panel C: Returns relative to beta × market return and intercept constrained to zero			
γ_1	1.072%	0.282%	0.61% to 1.54%
R-squared[69]	1.84%		
Panel D: Zero beta premium relative to the time-varying government bond yield			
γ_0	−0.022%	0.090%	−0.17% to 0.13%
γ_1	0.666%	0.282%	0.20% to 1.12%
γ_2	1.031	0.020	1.00 to 1.06
R-squared	76.80%		

Implications

119. The implications of this alternative set of analysis, and that conducted by NERA (2013) and CEG (2008), is that if the Sharpe-Lintner CAPM is used, or the Black CAPM is used, without consideration of additional risks, the cost of equity for the benchmark firm will be materially understated compared to the returns on Australian-listed stocks over the last four decades.[70] Stocks with low beta estimates earned returns much higher than predicted by the Sharpe-Lintner CAPM. The returns were sufficiently high that the return on a typical low beta stock exceeded the market return.

120. This has the following implication for estimating the cost of equity.

a) If we *assume* that stocks are priced only on the basis of systematic risk, the best estimate of the cost of equity from the historical data is given by the following equation.

$$r_e = r_z + \beta_e \times (r_m - r_z), \text{ and } r_z = r_f + 3.34\%.$$

In a companion report we provide estimates of the cost of equity under alternative equations that do not incorporate the assumption that stocks are priced according to only systematic risk.[71] We provide estimates of the cost of equity for the benchmark firm using the Fama-French model[72] and the dividend discount model because the weight on empirical evidence is that (1) the book-to-market factor is a priced risk factor for Australian-listed stocks, and (2) we are able to compile cost of equity estimates using the dividend discount model in which we do not need to specify, in advance, what risks we assume are, or are not, incorporated into stock prices.

[69] Note that it is not appropriate to compare the R-squared from a constrained regression to the R-squared from an unconstrained regression.
[70] The full NERA sample extends back to 1974.
[71] SFG Consulting (2014a).
[72] Fama and French (1993).

b) If there is no consideration of cost of equity estimates from other models, both our analysis and that of NERA (2013) and CEG (2008) support the conclusion that we cannot differentiate the expected return on a low beta stock, or a high beta stock, from the overall market return. If either the Sharpe-Lintner CAPM, or the Black CAPM, was used without consideration of any other risks, this would be inconsistent with historical returns. The reason the zero beta premium (9.28%) is higher than the market risk premium when portfolios are formed only from beta estimates is *because* stock returns are associated with risks other than those captured by the beta estimate.

c) Putting implication (a) and (b) together, this means that the best estimate of the cost of equity can be made using the Black CAPM *and* information that accounts for other risks. If information that accounts for other risks is ignored in estimating the cost of equity, and either the Sharpe-Lintner CAPM is used, the Black CAPM is used, or a combination is used, the evidence is that the cost of equity for the benchmark firm will be understated.

121. To make this point clear, we compiled the following table which shows the relationship between beta, the cost of equity in the Sharpe-Lintner CAPM and the cost of equity in the Black CAPM. The table also shows the beta input into the Sharpe-Lintner CAPM that implies the same return as the Black CAPM. The cost of equity estimates are also illustrated in Figure 11.

122. For the purposes of this discussion we assume an estimate of the risk-free rate of 4.12% per year and a market risk premium of 6.50% per year. The estimate of the risk-free rate is the annualised yield to maturity on 10-year government bonds for the 20 trading days ending on 12 February 2014. This is the same risk-free rate as assumed in our companion report on the cost of equity for a regulated energy network (SFG, 2014a). The market risk premium of 6.50% per year is the AER estimate from the Guideline. In out companion report, we rely upon a different estimate of the market risk premium, and incorporate our own estimate of the market risk premium in a later section of this report. But for the purposes of the current discussion we want to focus on issues relating to the use of the Black CAPM and not have the discussion distorted by the market risk premium assumption.

123. We begin with the average beta estimates for the low, medium and high beta portfolios, which are 0.80, 0.93 and 1.13, respectively. The corresponding cost of capital estimates under the Sharpe-Lintner CAPM are 9.34%, 10.17% and 11.46%, respectively. So the difference in cost of capital between high and low beta portfolios is 2.12% per year. If the Black CAPM were adopted, the range of cost of capital estimates narrows to 1.03% per year. Across low, medium and high beta portfolios, the cost of capital is 10.00%, 10.40% and 11.03%, respectively. To achieve the same expected returns in the Sharpe-Lintner CAPM the required beta estimates would need to be 0.90, 0.97 and 1.06, respectively.

124. A second set of beta estimates comprises those submitted to the AER by the Energy Networks Association (**ENA**) in our report entitled *Regression-based estimates of risk parameters for the benchmark firm* (SFG, 2013). We rely upon these beta estimates in a companion report to the current report, in which we reach a conclusion on the cost of equity for a listed energy network (SFG, 2014a). We previously compiled regression-based estimates of beta from Australian-listed stocks (0.58), U.S.-listed stocks (0.89) and a weighted average of stocks from both sets of firms (0.82).[73] The beta estimates corresponding to these stocks are presented in bold in the table above.

[73] Discussion about firm selection, estimation periods and estimation techniques is not an issue in the current report. The point of the discussion presented here is to demonstrate the impact on the cost of equity under the two alternative asset pricing equations, given an estimate of beta.

Table 5. Estimates of the cost of equity capital under alternative estimates for beta

Beta	Cost of equity in the Sharpe-Lintner CAPM [4.12% + β × (10.67% – 4.12%)]	Cost of equity in the Black CAPM [7.46% + β × (10.67% − 7.46%)]	Beta input in the Sharpe-Lintner CAPM that implies the same return as the Black CAPM
0.40	6.72	8.72	0.71
0.50	7.37	9.04	0.76
0.58 (Beta est. Aus.-listed)	**7.89**	**9.29**	**0.80**
0.60	8.02	9.36	0.81
0.70	8.67	9.67	0.85
0.80	9.32	9.99	0.90
0.80 (Low beta portfolio)[74]	9.34	10.00	0.90
0.82 (Beta est. recommend.)	**9.45**	**10.05**	**0.91**
0.89 (Beta est. U.S.-listed)	**9.91**	**10.27**	**0.95**
0.90	9.97	10.30	0.95
0.93 (Medium beta portfolio)	10.17	10.40	0.97
1.00	10.62	10.62	1.00
1.10	11.27	10.94	1.05
1.13 (High beta portfolio)	11.46	11.03	1.06
1.20	11.92	11.25	1.10
1.30	12.57	11.57	1.15
1.40	13.22	11.88	1.19
1.50	13.87	12.20	1.24
1.60	14.52	12.52	1.29

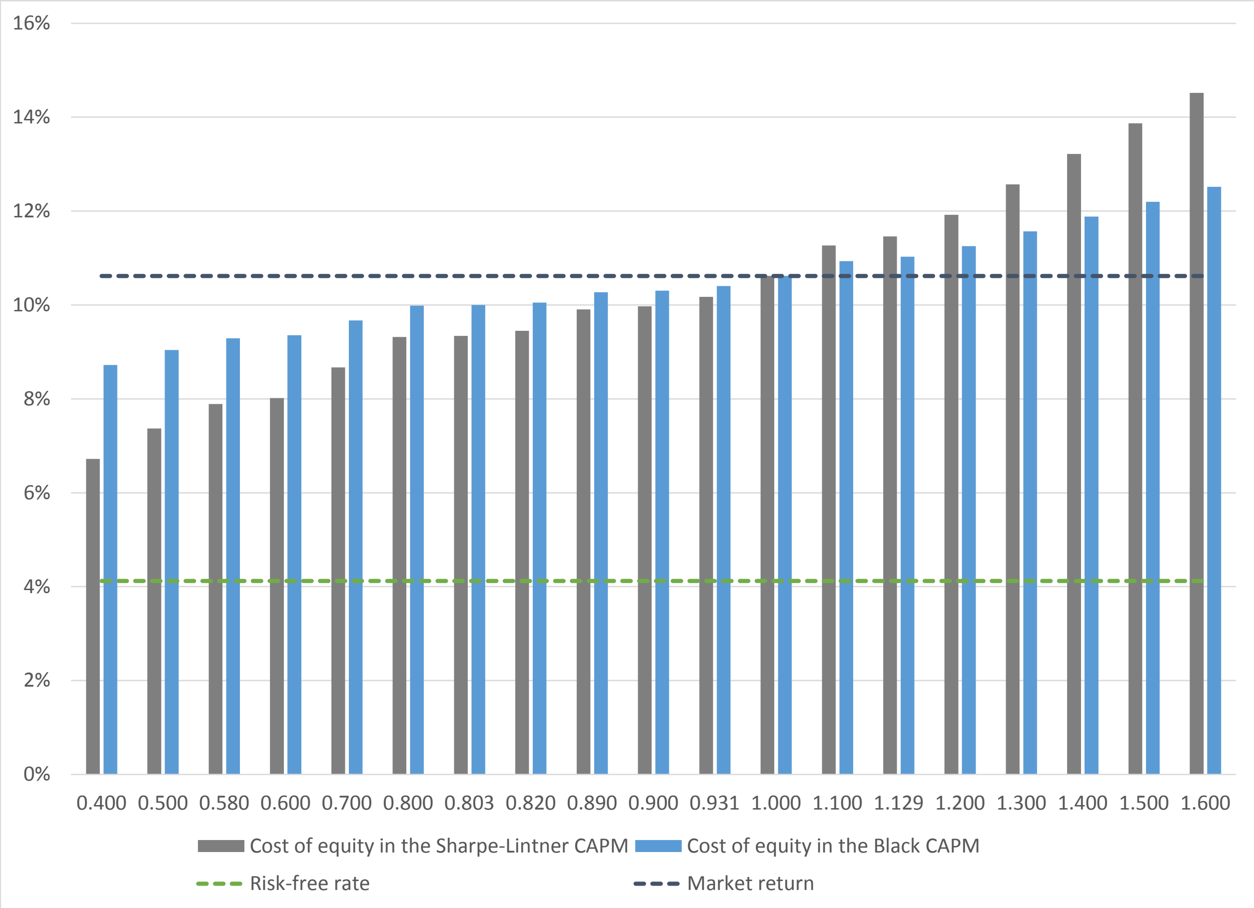
125. For stocks with a beta estimate of 0.58, the cost of equity under the Sharpe-Lintner CAPM is 7.89%. The cost of equity rises to 9.29% under the Black CAPM. For the Sharpe-Lintner CAPM to imply the same cost of equity estimate would require a beta estimate of 0.80. For stocks with a beta estimate of 0.89, the cost of equity under the Sharpe-Lintner CAPM is 9.91%, which increases to 10.27% under the Black CAPM. For the Sharpe-Lintner CAPM to imply the same cost of equity estimate would require a beta estimate of 0.95.

126. The final set of beta estimates to be discussed is the range of 0.4 to 0.7 that has been adopted by the AER. At the lower end of the AER's preferred range, the cost of equity under the Sharpe-Lintner CAPM is 6.72%. Under the Black CAPM the cost of equity would be 8.72%. In order to achieve the same cost of equity estimate in the Sharpe-Lintner CAPM, the beta estimate would need to be 0.71.

127. At the upper end of the AER's preferred range, the cost of equity under the Sharpe-Lintner CAPM is 8.20%. Under the Black CAPM the cost of equity would be 9.67%. In order to achieve the same cost of equity estimate in the Sharpe-Lintner CAPM, the beta estimate would need to be 0.85.

[74] The average beta estimate used in computation is 0.803, which is the reason for the small difference in expected returns compared to that which results from a beta estimate of 0.80.

Figure 11. Estimates of the cost of equity capital under alternative estimates for beta



128. In estimating the cost of equity under the Black CAPM there are three distinct inputs – an estimate of the return on a zero beta asset, an estimate of beta and an estimate of the expected market return. The approach adopted in the Guideline is to implement the Sharpe-Lintner CAPM, which is a specific model in which the return on a zero beta asset is set equal to an estimate of the risk-free rate. In the Guideline the AER has acknowledged the potential for this approach to understate the cost of equity capital, given that stocks with low beta estimates have historically earned returns that are too high compared to the predictions of the Sharpe-Lintner CAPM.[75] To account for the potential for the Sharpe-Lintner CAPM to understate returns, the AER selects a beta estimate from the upper end of its range of 0.4 to 0.7.

129. Under this approach, it is unclear how much relative consideration will be given to the Sharpe-Lintner CAPM or the Black CAPM in any given situation. The range for beta referred to by the AER corresponds to a set of different point estimates that rely upon different time periods and regression techniques, but the range does not rely upon any expansion of the set of sample firms. So the beta estimates from different papers are the result of re-estimating beta using largely the same set of returns over and over again, with some variation in start and end points, and with regression techniques that rely upon different weighting schemes. The range is not impacted in any way by consideration of firms outside the set of nine Australian-listed firms, nor is the range impacted by the consideration of whether the Sharpe-Lintner CAPM is a reliable model for estimating the cost of equity.

[75] AER Appendix C.4.3, pp. 71–73.

130. Information from (1) U.S.-listed stocks and (2) consideration of the Black CAPM are both adopted as second-order considerations to arrive at a final beta estimate from within the range. So further information about the reliability of either U.S.-listed stocks or the zero beta premium in the Black CAPM can only take effect if it is used to widen the range for beta – but the range for beta has been estimated with respect to regression estimates for Australian-listed firms.

131. An approach to estimating the cost of equity that is not affected by this concern is to populate the Sharpe-Lintner CAPM, populate the Black CAPM and any other relevant model, and give relative consideration to each model depending upon the an assessment of the models' reliability. According to the data available to us, the best estimate of the zero beta premium is 3.34%, and this input can be used to populate the Black CAPM.

132. However, if the resulting Black CAPM cost of equity is used without consideration of risks not captured by the beta estimate, the cost of equity will be understated. It cannot be established in the empirical data that either the Sharpe-Lintner CAPM, or the Black CAPM, captures all risks associated with stocks. If the Black CAPM is used with a zero beta premium of 3.34%, and if no consideration is given to risks not proxied by beta estimates, the cost of equity will be understated.[76]

Precision of the estimate of the zero beta return

133. In this section we discuss the precision of the estimate of the zero beta return. In Table 3, Panel A we presented an estimate of the zero beta return of 0.688% over four weeks. Given the standard error of this estimate, the 90% confidence interval is 0.05% to 1.33% over four weeks. This means that the estimate if the zero beta return is not significantly different to the average market return of 0.900%, neither is it statistically different to the average estimate of the risk-free rate of 0.449%. This is consistent with the estimate of the zero beta premium from Table 3, Panel D, 0.238%, which has a 90% confidence interval of –0.40% to 0.88%.

134. This means that, if portfolios are formed which only vary materially on the basis of beta estimates (so have the same industry, size and book-to-market characteristics), the statistical range for the zero beta premium spans a range of zero and the market risk premium. In contrast, if portfolios are formed only on the basis of beta estimates the 90% confidence interval for the zero beta return is 0.63% to 1.56%. This latter confidence interval is materially above the risk-free rate of 0.449% per month and is not statistically different from the average market return of 0.900% per month.[77]

135. This means that the implications from the previous sub-section can be placed in a statistical context, in light of the cost of equity approach adopted in the Guideline. In the Guideline the AER selects a beta estimate at the top of its baseline range of 0.4 to 0.7. The AER also places no weight on any other risk factor, apart from systematic risk. The upper end of the range is selected on the basis of an unspecified consideration given to the evidence for U.S.-listed firms and an unspecified consideration given to the Black CAPM. This means that the AER has not made an assumption regarding the zero beta premium as it could lie anywhere from 0% to 3%. To reach the AER's conclusion on beta (0.7)

[76] This is not a theoretical consideration. The alternative approaches to estimating the cost of equity, available to the AER, are the Fama-French model and the dividend discount model, as described in our companion report (SFG, 2014a) and supporting reports on the specific models.

[77] The standard errors that underpin our analysis can be compared to the standard errors reported by NERA (2013). Converting our standard errors to annual figures using the delta method recommended by NERA we have a standard error of 5.51% per year for the zero beta return from the portfolios matched on industry, size and book-to-market ratio, and a standard error of 4.20% per year for the zero beta return from the portfolios formed only with respect to beta. Using data from 1974 to 2013, NERA reports standard errors from portfolio analysis using data from 1974 to 2013 of 5.48% per year (Table 5.2, p. 16), 4.09% per year (Table 5.6), and 5.46% per year (Table C.3). Using data from 1994 to 2012 the portfolio standard errors are 4.70% per year (Table 5.3) and 4.69% per year (Table C.3).

the zero beta premium could be as low as zero (and some consideration given to U.S.-listed firms) or the zero beta premium could be as high as 3% (and the AER has adopted a beta estimate at the low end of its range (0.4) and zero consideration is given to U.S.-listed firms).[78]

136. The key point is that the AER has made an implicit assumption about the zero beta premium, jointly with an implicit assumption about the relevance of beta estimates for U.S.-listed stocks. The implicit assumption for the zero beta premium seems to be less than 3%. This means that an estimate for the cost of equity derived from the AER approach is statistically lower than implied by the historical returns information. This occurs because the AER approach does not account for the empirical evidence that not all priced risks are captured by beta estimates.

137. In summary, the result that the zero beta premium of 3.34% is not statistically different from zero or a market risk premium assumption of 6.50% *cannot* be interpreted as support for the approach of the AER. The correct interpretation is that, provided all risks not captured by beta estimates are properly accounted for elsewhere, the best estimate of the zero beta premium is 3.34%.

138. It is also *not* the case that the Sharpe-Lintner CAPM should be adopted in preference to the Black CAPM, on the basis that the zero beta return could, statistically, be equal to the risk-free rate. We could equally say that the zero beta return is not statistically different to the market return. This means there is no statistical evidence in historical returns to determine that a low beta stock has expected returns that are any different to the market return. The Sharpe-Lintner CAPM is not specified by the Rules as a default model, to only be applied unless there is statistical evidence to the contrary. The AER has adopted one statistical technique for measuring beta (regressions on historical returns, albeit with variants of regressions on historical returns) and it cannot be established, statistically, that the resulting beta estimates, incorporated into the Sharpe-Lintner CAPM, lead to cost of equity estimates that are more reliable than the market return.

[78] This example relies upon the 4% risk-free rate and 6% market risk premium assumptions used in the example presented in the AER Guideline and discussed earlier.

5. Summary and conclusions

139. The Black CAPM is a general version of the Sharpe-Lintner CAPM, and states that the expected return on a risky asset is equal to the return on a zero beta asset (r_z) plus a premium for bearing systematic risk [$\beta \times (r_m - r_z)$]. The *zero beta premium* refers to the difference between the return on a zero beta asset and the risk-free rate ($r_z - r_f$).

140. The development of the Black CAPM as a theoretical concept followed initial empirical testing of the Sharpe-Lintner CAPM in the early 1970's. The empirical testing showed that stocks with low beta estimates earn higher returns than predicted by the Sharpe-Lintner CAPM and this result is now supported by more than 80 years of stock returns.

141. The poor empirical performance of the Sharpe-Lintner CAPM likely occurs for two reasons. First, risks other than systematic risk are incorporated into share prices (in particular, stocks with a high book-to-market ratio persistently earn higher returns than stocks with a low book-to-market ratio). Second, the common measurement of systematic risk – the regression coefficient of excess stock returns on market returns – is an imprecise measure of risk.

142. The terms of reference require us to estimate the cost of equity from the Black CAPM that is commensurate with prevailing conditions in the market for funds and reflects efficient financing costs for a benchmark efficient entity. In reaching this conclusion we relied upon the following assumptions.

    a) We compiled an estimate of the zero beta premium that accounts only for the relationship between historical stock returns and beta estimates. We performed our analysis to mitigate the impact of other firm characteristics likely to be associated with stock returns – industry, size and book-to-market ratio. Our zero beta premium estimate from this analysis is 3.34% per year.

    b) In a companion report (SFG, 2014a) we provide an estimate of the market risk premium of 7.21% and an estimate for equity beta for a benchmark firm of 0.82. For the 20 trading days ending on 12 February 2014 the average yield to maturity on 10-year government bonds was 4.12% and this is our estimate of the risk-free rate.

143. **This means that our best estimate of the cost of equity in the Black CAPM is equal to 10.62%, computed as:**

    (Risk-free rate + Zero beta premium) + Equity beta × [Market return – (Risk-free rate + zero beta premium)]

    = (4.12% + 3.34%) + 0.82 × [(4.12% + 7.21%) – (4.12% + 3.34%)]

    = 7.46% + 0.82 × [11.32% – 7.46%]

    = 7.46% + 0.82 × 3.87%

    = 7.46% + 3.16%

    = 10.62%.

144. Our estimate of the zero beta premium and cost of equity in the Black CAPM is only appropriate if risks other than those proxied by the beta estimate are incorporated elsewhere. The zero beta premium estimate of 3.34% means that, for a stock with risks on other dimensions no different to the average firm, the expected return can be given by the Black CAPM equation, incorporating a zero beta premium of 3.34%.

145. In particular, stocks with above-average book-to-market ratios would be expected to have returns above that predicted by the Black CAPM and a zero beta premium of 3.34%. If the risks associated with high book-to-market stocks are not incorporated elsewhere, and the Black CAPM alone is used to estimate the cost of equity with a zero beta premium of 3.34%, the cost of equity will be understated.

Declaration

146. We confirm that 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.

Professor Stephen Gray.

Dr Jason Hall.

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Appendix 1: Instructions

Expert Terms of Reference

Applying the Black CAPM in Australia

Jemena Gas Networks
2015-20 Access Arrangement Review

AA15-570-0049

Version C – 7 May 2014

Contact Person

Cameron Herbert

Senior Legal Counsel

Jemena Limited

ABN 95 052 167 405

321 Ferntree Gully Road
Mt Waverley VIC 3149

Postal Address:

Locked Bag 7000
Mt Waverley VIC 3149

Ph: (03) 8544 9000

Fax: (03) 8544 9888

Version	Status	Date	Prepared	Checked	Authorised
A	Draft	13/02/14	E Grace-Webb		
B	Draft	21/02/14	E Grace-Webb		
C	Final	07/05/14	E Grace-Webb		E Grace-Webb

Contents

1 Background

Jemena Gas Networks (**JGN**) is the major gas distribution service provider in New South Wales (**NSW**). JGN owns more than 25,000 kilometres of natural gas distribution system, delivering approximately 100 petajoules of natural gas to over one million homes, businesses and large industrial consumers across NSW.

JGN is currently preparing its revised Access Arrangement proposal (**Project**) with supporting information for the consideration of the Australian Energy Regulator (**AER**). The revised access arrangement will cover the period 1 July 2015 to 30 June 2020 (July to June financial years).

As with all of its economic regulatory functions and powers, when assessing JGN's revised Access Arrangement under the National Gas Rules and the National Gas Law, the AER is required to do so in a manner that will or is likely to contribute to the achievement of the National Gas Objective, which is:

> "to promote efficient investment in, and efficient operation and use of, natural gas services for the long term interests of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas."

For electricity networks, the AER must assess regulatory proposals under the National Electricity Rules and the National Electricity Law in a manner that will or is likely to achieve the National Electricity Objective, as stated in section 7 of the National Electricity Law.

The AER must also take into account the revenue and pricing principles in section 24 of the National Gas Law and section 7A of the National Electricity Law, when exercising a discretion related to reference tariffs. The revenue and pricing principles include the following:

> "(2) A service provider should be provided with a reasonable opportunity to recover at least the efficient costs the service provider incurs in—
>
> a) providing reference services; and
>
> b) complying with a regulatory obligation or requirement or making a regulatory payment.
>
> (3) A service provider should be provided with effective incentives in order to promote economic efficiency with respect to reference services the service provider provides. The economic efficiency that should be promoted includes—
>
> (a) efficient investment in, or in connection with, a pipeline with which the service provider provides reference services…
>
> […]
>
> (5) A reference tariff should allow for a return commensurate with the regulatory and commercial risks involved in providing the reference service to which that tariff relates.

(6) Regard should be had to the economic costs and risks of the potential for under and over investment by a service provider in a pipeline with which the service provider provides pipeline services."

Some of the key rules that are relevant to an access arrangement and its assessment are set out below.

Rule 74 of the National Gas Rules, relating generally to forecasts and estimates, states:

(1) Information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.

(2) A forecast or estimate:

(a) must be arrived at on a reasonable basis; and

(b) must represent the best forecast or estimate possible in the circumstances.

Rule 87 of the National Gas Rules, relating to the allowed rate of return, states:

(1) Subject to rule 82(3), the return on the projected capital base for each regulatory year of the access arrangement period is to be calculated by applying a rate of return that is determined in accordance with this rule 87 (the allowed rate of return).

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

(3) The allowed rate of return objective is that the rate of return for a service provider is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the service provider in respect of the provision of reference services (the allowed rate of return objective).

(4) Subject to subrule (2), the allowed rate of return for a regulatory year is to be:

(a) a weighted average of the return on equity for the access arrangement period in which that regulatory year occurs (as estimated under subrule (6)) and the return on debt for that regulatory year (as estimated under subrule (8)); and

(b) determined on a nominal vanilla basis that is consistent with the estimate of the value of imputation credits referred to in rule 87A.

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

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

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

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

Return on equity

(6) The return on equity for an access arrangement period is to be estimated such that it contributes to the achievement of the allowed rate of return objective.

(7) In estimating the return on equity under subrule (6), regard must be had to the prevailing conditions in the market for equity funds.

[Subrules (8)–(19) omitted].

The equivalent National Electricity Rules are in clauses 6A.6.2 (for electricity transmission) and 6.5.2 (for electricity distribution).

Accordingly, the independent opinion of SFG Consulting, as a suitably qualified independent expert (**Expert**), is sought on using the Black CAPM to estimate a return on equity that complies with the requirements of the National Gas Law and Rules and National Electricity Law and Rules, including as highlighted above. JGN seeks this opinion on behalf of itself, ActewAGL, Ergon, Networks NSW, Transend, and SA PowerNetworks.

2 Scope of Work

The Expert will provide an opinion report that:

1. describes the Black CAPM, its key parameters and inputs, and the theoretical and empirical basis for its development;

2. describes how the Black CAPM is applied in practice (and is used to estimate the return on equity) in Australia;

3. uses the Black CAPM to estimate the return on equity for a benchmark efficient entity in Australia that is:

    (a) commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to a regulated gas or electricity network in respect of the provision of reference services; and

    (b) reflective of prevailing conditions in the market for equity funds.

In preparing the report, the Expert will:

A. consider different approaches to applying the Black CAPM and estimating the zero-beta premium, including any theoretical restrictions on empirical estimates;

B. consider the stability of estimates of the zero-beta premium over time;

C. consider any comments raised by the AER and other regulators about (i) whether the Black CAPM applies in Australia and (ii) the best estimate of the zero-beta premium for Australia;

D. use robust methods and data; and

E. use the sample averaging period of the 20 business days to 12 February 2014 (inclusive) to estimate any prevailing parameter estimates needed to populate the Black CAPM.

3 Information Provided by JGN

The Expert is encouraged to draw upon the following information which JGN will make available:

- an expert report by NERA Economic Consulting titled "Estimates of the Zero-Beta Premium", dated June 2013; and
- other relevant expert reports on the Black CAPM.

4 Other Information to be Considered

The Expert is also expected to consider the following additional information:

- such information that, in Expert's opinion, should be taken into account to address the questions outlined above;
- relevant literature on the rate of return;
- the AER's rate of return guideline, including explanatory statements and supporting expert material;
- material submitted to the AER as part of its consultation on the rate of return guideline; and
- previous decisions of the AER, other relevant regulators and the Australian Competition Tribunal on the rate of return and any supporting expert material.

5 Deliverables

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

- is of a professional standard capable of being submitted to the AER;
- is prepared in accordance with the Federal Court Practice Note on Expert Witnesses in Proceedings in the Federal Court of Australia (CM 7) set out in Attachment 1, and includes an acknowledgement that the Expert has read the guidelines [1];

[1] Available at: http://www.federalcourt.gov.au/law-and-practice/practice-documents/practice-notes/cm7.

- contains a section summarising the Expert's experience and qualifications, and attaches the Expert's curriculum vitae (preferably in a schedule or annexure);

- identifies any person and their qualifications, who assists the Expert in preparing the report or in carrying out any research or test for the purposes of the report;

- summarises JGN's instructions and attaches these term of reference;

- includes an executive summary which highlights key aspects of the Expert's work and conclusions; and

- (without limiting the points above) carefully sets out the facts that the Expert has assumed in putting together his or her report, as well as identifying any other assumptions made, and the basis for those assumptions.

The Expert's report will include the findings for each of the five parts defined in the scope of works (Section 2).

6 Timetable

The Expert will deliver the final report to Jemena Regulation by **30 April 2014**.

7 Terms of Engagement

The terms on which the Expert will be engaged to provide the requested advice shall be:

- as provided in accordance with the Jemena Regulatory Consultancy Services Panel arrangements applicable to the Expert.

ATTACHMENT 1: FEDERAL COURT PRACTICE NOTE

Practice Note CM 7

EXPERT WITNESSES IN PROCEEDINGS IN THE FEDERAL COURT OF AUSTRALIA

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[2], 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.

<u>Guidelines</u>

1. General Duty to the Court[3]

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[4]

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

---

2 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].

3 The "*Ikarian Reefer*" (1993) 20 FSR 563 at 565-566.

4 Rule 23.13.

(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[5]; and

(h) comply with the Practice Note.

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

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

2.4 If, after exchange of reports or at any other stage, an expert witness changes the expert's opinion, having read another expert's report or for any other reason, the change should be communicated as soon as practicable (through the party's lawyers) to each party to whom the expert witness's report has been provided and, when appropriate, to the Court[6].

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[7].

3. Experts' Conference

3.1 If experts retained by the parties meet at the direction of the Court, it would be improper for an expert to be given, or to accept, instructions not to reach agreement. If, at a meeting directed by the Court, the experts cannot reach agreement about matters of expert opinion, they should specify their reasons for being unable to do so.

J L B ALLSOP
Chief Justice
4 June 2013

[5] See also *Dasreef Pty Limited v Nawaf Hawchar* [2011] HCA 21.

[6] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565

[7] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565-566. See also Ormrod *"Scientific Evidence in Court"* [1968] Crim LR 240

Appendix 2: Curriculum Vitas of Professor Stephen Gray and Dr Jason Hall

Stephen F. Gray

University of Queensland
Business School
Brisbane 4072
AUSTRALIA
Office: +61-7-3346 8032
Email: s.gray@business.uq.edu.au

Academic Qualifications

1995 Ph.D. (Finance), Graduate School of Business, Stanford University.
Dissertation Title: Essays in Empirical Finance
Committee Chairman: Ken Singleton
1989 LL.B. (Hons), Bachelor of Laws with Honours, University of Queensland.
1986 B.Com. (Hons), Bachelor of Commerce with Honours, University of Queensland.

Employment History

2000-Present Professor of Finance, UQ Business School, University of Queensland.
1997-2000 Associate Professor of Finance, Department of Commerce, University of Queensland and Research Associate Professor of Finance, Fuqua School of Business, Duke University.
1994-1997 Assistant Professor of Finance, Fuqua School of Business, Duke University.
1990-1993 Research Assistant, Graduate School of Business, Stanford University.
1988-1990 Assistant Professor of Finance, Department of Commerce, University of Queensland.
1987 Specialist Tutor in Finance, Queensland University of Technology.
1986 Teaching Assistant in Finance, Department of Commerce, University of Queensland.

Academic Awards

2006 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
2002 Journal of Financial Economics, All-Star Paper Award, for Modeling the Conditional Distribution of Interest Rates as a Regime-Switching Process, JFE, 1996, 42, 27-62.
2002 Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).
2000 University of Queensland Award for Excellence in Teaching (a University-wide award).
1999 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
1999 KPMG Teaching Prize, Department of Commerce, University of Queensland.
1998 Faculty Teaching Prize (Business, Economics, and Law), University of Queensland.
1991 Jaedicke Fellow in Finance, Doctoral Program, Graduate School of Business, Stanford University.
1989 Touche Ross Teaching Prize, Department of Commerce, University of Queensland.
1986 University Medal in Commerce, University of Queensland.

Large Grants (over $100, 000)

- Australian Research Council Linkage Grant, 2008—2010, Managing Asymmetry Risk ($320,000), with T. Brailsford, J.Alcock, and Tactical Global Management.
- Intelligent Grid Cluster, Distributed Energy – CSIRO Energy Transformed Flagship Collaboration Cluster Grant, 2008-2010 ($552,000)
- Australian Research Council Research Infrastructure Block Grant, 2007—2008, Australian Financial Information Database ($279,754).
- Australian Research Council Discovery Grant, 2006—2008, Capital Management in a Stochastic Earnings Environment ($270,000).
- Australian Research Council Discovery Grant, 2005—2007, Australian Cost of Equity.
- Australian Research Council Discovery Grant, 2002—2004, Quantification Issues in Corporate Valuation, the Cost of Capital, and Optimal Capital Structure.

- Australian Research Council Strategic Partnership Grant, 1997—2000, Electricity Contracts and Securities in a Deregulated Market: Valuation and Risk Management for Market Participants.

Current Research Interests

Benchmark returns and the cost of capital. Corporate Finance. Capital structure. Real and strategic options and corporate valuation. Financial and credit risk management. Empirical finance and asset pricing.

Publications

Chan, K-F., R. Brooks, S. Treepongkaruna and S. Gray, (2011), "Do Trading Hours Affect Volatility Links in the Foreign Exchange Market?" *Australian Journal of Management*, forthcoming.

Chan, K-F., R. Brooks, S. Treepongkaruna and S. Gray, (2010), "Asset market linkages: Evidence from financial, commodity and real estate assets," *Journal of Banking and Finance*, forthcoming.

Parmenter, B, A. Breckenridge, and S. Gray, (2010), 'Economic Analysis of the Government's Recent Mining Tax Proposals', *Economic Papers*: *A Journal of Economics and Policy*, 29(3), September, 279-91.

Gray, S., C. Gaunt and Y. Wu, (2010), "A comparison of alternative bankruptcy prediction models," *Journal of Contemporary Accounting and Economics*, 6, 1, 34-45.

Feuerherdt, C., S. Gray and J. Hall, (2010), "The Value of Imputation Tax Credits on Australian Hybrid Securities," *International Review of Finance*, 10, 3, 365-401.

Gray, S., J. Hall, D. Klease and A. McCrystal, (2009), "Bias, stability and predictive ability in the measurement of systematic risk," *Accounting Research Journal*, 22, 3, 220-236.

Treepongkaruna, S. and S. Gray, (2009), "Information volatility links in the foreign exchange market," *Accounting and Finance*, 49, 2, 385-405.

Costello, D., S. Gray, and A. McCrystal, (2008), "The diversification benefits of Australian equities," *JASSA*, 2008, 4, 31-35.

Gray, S. and J. Hall, (2008), "The Relationship Between Franking Credits and the Market Risk Premium: A Reply," *Accounting and Finance*, 48, 1, 133-142.

Gray, S., A. Mirkovic and V. Ragunathan, (2006), "The Determinants of Credit Ratings: Australian Evidence," *Australian Journal of Management*, 31(2), 333-354.

Choy, E., S. Gray and V. Ragunathan, (2006), "The Effect of Credit Rating Changes on Australian Stock Returns," *Accounting and Finance*, 46(5), 755-769.

Gray, S. and J. Hall, (2006), "The Relationship Between Franking Credits and the Market Risk Premium," *Accounting and Finance*, 46(3), 405-428.

Gray, S. and S. Treepongkaruna, (2006), "Are there non-linearities in short-term interest rates?" *Accounting and Finance*, 46(1), 149-167.

Gray, P., S. Gray and T. Roche, (2005), "A Note on the Efficiency in Football Betting Markets: The Economic Significance of Trading Strategies," *Accounting and Finance*, 45(2) 269-281.

Duffie, D., S. Gray and P. Hoang, (2004), "Volatility in Energy Prices. In V. Kaminski," (Ed.), *Managing Energy Price Risk: The New Challenges and Solutions* (3rd ed.). London: Risk Books.

Cannavan, D., F. Finn and S. Gray, (2004), "The Value of Dividend Imputation Tax Credits in Australia," *Journal of Financial Economics*, 73, 167-197.

Gray, S. and S. Treepongkaruna, (2003), "Valuing Interest Rate Derivatives Using a Monte-Carlo Approach," *Accounting and Finance*, 43(2), 231-259.

Gray, S., T. Smith and R. Whaley, (2003), "Stock Splits: Implications for Investor Trading Costs," *Journal of Empirical Finance*, 10, 271-303.

Gray, S. and S. Treepongkaruna, (2003), "On the Robustness of Short-term Interest Rate Models," *Accounting and Finance*, 43(1), 87-121.

Gray, S. and S. Treepongkaruna, (2002), "How to Value Interest Rate Derivatives in a No-Arbitrage Setting," *Accounting Research Journal* (15), 1.

Gray, P. and S. Gray, (2001), "A Framework for Valuing Derivative Securities," *Financial Markets Institutions & Instruments*, 10(5), 253-276.

Gray, P. and S. Gray, (2001), "Option Pricing: A Synthesis of Alternate Approaches," *Accounting Research Journal*, 14(1), 75-83.

Dahlquist, M. and S. Gray, (2000), "Regime-Switching and Interest Rates in the European Monetary System," *Journal of International Economics*, 50(2), 399-419.

Bollen, N., S. Gray and R. Whaley, (2000), "Regime-Switching in Foreign Exchange Rates: Evidence from Currency Options," *Journal of Econometrics*, 94, 239-276.

Duffie, D., S. Gray and P. Hoang, (1999), "Volatility in Energy Prices. In R. Jameson," (Ed.), *Managing Energy Price Risk* (2nd ed.). London: Risk Publications.

Gray, S. and R. Whaley, (1999), "Reset Put Options: Valuation, Risk Characteristics, and an Example," *Australian Journal of Management*, 24(1), 1-21.

Bekaert, G. and S. Gray, (1998), "Target Zones and Exchange Rates: An Empirical Investigation," *Journal of International Economics*, 45(1), 1-35.

Gray, S. and R. Whaley, (1997), "Valuing S&P 500 Bear Market Warrants with a Periodic Reset," *Journal of Derivatives*, 5(1), 99-106.

Gray, S. and P. Gray, (1997), "Testing Market Efficiency: Evidence from the NFL Sports Betting Market," *The Journal of Finance*, 52(4), 1725-1737.

Gray, S. (1996), "Modeling the Conditional Distribution of Interest Rates as a Regime- Switching Process," *Journal of Financial Economics*, 42, 27-62.

Gray, S. (1996), "Regime-Switching in Australian Interest Rates," *Accounting and Finance*, 36(1), 65-88.

Brailsford, T., S. Easton, P.Gray and S. Gray, (1995), "The Efficiency of Australian Football Betting Markets," *Australian Journal of Management*, 20(2), 167-196.

Duffie, D. and S. Gray, (1995), "Volatility in Energy Prices," In R. Jameson (Ed.), *Managing Energy Price Risk*, London: Risk Publications.

Gray, S. and A. Lynch, (1990), "An Alternative Explanation of the January Anomaly," *Accounting Research Journal*, 3(1), 19-27.

Gray, S. (1989), "Put Call Parity: An Extension of Boundary Conditions," *Australian Journal of Management*, 14(2), 151-170.

Gray, S. (1988), "The Straddle and the Efficiency of the Australian Exchange Traded Options Market," *Accounting Research Journal*, 1(2), 15-27.

Teaching

Fuqua School of Business, Duke University, Student Evaluations (0-7 scale):

- Financial Management (MBA Core): Average 6.5 over 7 years.
- Advanced Derivatives: Average 6.6 over 4 years.
- Empirical Issues in Asset Pricing: Ph.D. Class

1999, 2006 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.

UQ Business School, University of Queensland, Student Evaluations (0-7 scale):

- Finance (MBA Core): Average 6.6 over 10 years.
- Corporate Finance Honours: Average 6.9 over 10 years.

2002 Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).

2000 University of Queensland Award for Excellence in Teaching.
1999 Department of Commerce KPMG Teaching Prize, University of Queensland.
1998 Faculty Teaching Prize, Faculty of Business Economics and Law, University of Queensland.
1998 Commendation for Excellence in Teaching, University-wide Teaching Awards, University of Queensland.
1989 Touche Ross Teaching Prize, Department of Commerce, University of Queensland.

Board Positions

2002 - Present: Director, Financial Management Association of Australia Ltd.
2003 - Present: Director, Moreton Bay Boys College Ltd. (Chairman since 2007).
2002 - 2007: External Risk Advisor to Board of Enertrade (Queensland Power Trading Corporation Ltd.)

Consulting

Managing Director, Strategic Finance Group: www.sfgconsulting.com.au.

Consulting interests and specialties, with recent examples, include:

- **Corporate finance**
  - ⇒ **Listed multi-business corporation:** Detailed financial modeling of each business unit, analysis of corporate strategy, estimation of effects of alternate strategies, development of capital allocation framework.

- **Capital management and optimal capital structure**
  - ⇒ **State-owned electricity generator:** Built detailed financial model to analyze effects of increased leverage on cost of capital, entity value, credit rating, and stability of dividends. Debt of $500 million issued.

- **Cost of capital**
  - ⇒ **Cost of Capital in the Public Sector:** Provided advice to a government enterprise on how to estimate an appropriate cost of capital and benchmark return for Government-owned enterprises. Appearance as **expert witness** in legal proceedings that followed a regulatory determination.
  - ⇒ **Expert Witness:** Produced a written report and provided court testimony on issues relating to the cost of capital of a cable TV business.
  - ⇒ **Regulatory Cost of Capital:** Extensive work for regulators and regulated entities on all matters relating to estimation of weighted-average cost of capital.

- **Valuation**
  - ⇒ **Expert Witness:** Produced a written report and provided court testimony. The issue was whether, during a takeover offer, the shares of the bidding firm were affected by a liquidity premium due to its incorporation in the major stock market index.
  - ⇒ **Expert Witness:** Produced a written report and provided court testimony in relation to valuation issues involving an integrated mine and refinery.

- **Capital Raising**
  - ⇒ Produced comprehensive valuation models in the context of capital raisings for a range of businesses in a range of industries including manufacturing, film production, and biotechnology.

- **Asset pricing and empirical finance**
  - ⇒ **Expert Witness:** Produced a written report on whether the client's arbitrage-driven trading strategy caused undue movements in the prices of certain shares.

- **Application of econometric techniques to applied problems in finance**
  - ⇒ **Debt Structure Review:** Provided advice to a large City Council on restructuring their debt portfolio. The issues involved optimisation of a range of performance measures for each business unit in the Council while simultaneously minimizing the volatility of the Council's equity in each business unit.

⇒ **Superannuation Fund Performance Benchmarking:** Conducted an analysis of the techniques used by a large superannuation fund to benchmark its performance against competing funds.

- **Valuation of derivative securities**
  ⇒ **Stochastic Volatility Models in Interest Rate Futures Markets:** Estimated and implemented a number of models designed to predict volatility in interest rate futures markets.

- **Application of option-pricing techniques to real project evaluation**
  ⇒ **Real Option Valuation:** Developed a framework for valuing an option on a large office building. Acted as arbitrator between the various parties involved and reached a consensus valuation.
  ⇒ **Real Option Valuation:** Used real options framework in the valuation of a bio-tech company in the context of an M&A transaction.

Jason Hall, PhD BCom(Hons) CFA

Lecturer in Finance
Ross School of Business
The University of Michigan (Room 4443)
701 Tappan Avenue
Ann Arbor, Michigan, USA 48104
Phone: +1 734 926 6989
Email: uqjhall@umich.edu
Research: http://ssrn.com/author=114606

Director
SFG Consulting
Level 1, South Bank House, Stanley Street Plaza
South Bank, Queensland, Australia 4101
Phone: +61 419 120 348
Email: j.hall@sfgconsulting.com.au
Website: sfgconsulting.com.au
Skype: jason.lance.hall

Experience

2013-14	Ross School of Business, The University of Michigan (Lecturer in Finance)
2008	Ross School of Business, The University of Michigan (Visiting Assistant Professor in Finance)
2000-14	SFG Consulting (Director)
2000-12	University of Queensland Business School, The University of Queensland (Senior Lecturer)
1997-99	Credit Suisse First Boston (Equities analyst)

Education

2005	PhD in finance from The University of Queensland
2003	Chartered Financial Analyst designation by the CFA Institute
1996	Bachelor of Commerce with First Class Honours from The University of Queensland

Research

Journal articles

Impact of sector versus security choice on equity portfolios, with Ben McVicar, *Applied Financial Economics*, 2013, 23 (12), 991 – 1004.

Unconstrained estimates of the equity risk premium, with Stephen Gray, Tristan Fitzgerald and Ravi Jeyaraj, *Review of Accounting Studies*, 2013, 18 (2), 560 – 639.

Market risk exposure of merger arbitrage in Australia, with Matthew Pinnuck and Matthew Thorne, *Accounting and Finance*, 2013, 53 (1), 185 – 215.

The value of imputation credits on hybrid securities, with Clinton Feuerherdt and Stephen Gray, *International Review of Finance*, 2010, 10 (3), 365 – 401.

Forecast accuracy and stock recommendations, with Paul Tacon, *Journal of Contemporary Accounting and Economics*, 2010, 6 (1), 18 – 33.

Speculation and e-commerce: The long and the short of IT, with Colin Ferguson, Matthew Pinnuck and Frank Finn, *International Journal of Accounting Information Systems*, 2010, 11 (2), 79 – 104.

Bias, stability and predictive ability in the measurement of systematic risk, with Stephen Gray, Drew Klease and Alan McCrystal, *Accounting Research Journal*, 2009, 22 (3), 220 – 236.

Leveraged superannuation, with Peter Dunn and Scott Francis, *Accounting and Finance*, 2009, 49 (3), 505 – 529.

Persistence in growth versus market expectations, with Matthew Tochterman, *Australian Journal of Management*, 2008, 33 (1), 169 – 199.

Relationship between franking credits and the market risk premium: A reply, with Stephen Gray, *Accounting and Finance*, 2008, 48 (1), 133 – 142.

Comment on 'Regulation and the term of the risk free rate: Implications of corporate debt', *Accounting Research Journal*, 2007, 20 (2), 81 – 86.

Valuation of mining projects using option pricing techniques, with Shannon Nicholls, *JASSA*, 2007, Issue 4 (Summer), 22 – 29.

Relationship between franking credits and the market risk premium, with Stephen Gray, *Accounting and Finance*, 2006, 46 (3), 405 – 428.

Electronic commerce investments, the resource-based view of the firm, and firm market value, with Colin Ferguson and Frank Finn, *International Journal of Accounting Information Systems*, 2005, 6 (1), 5 – 29.

Auditor conservatism and voluntary disclosure: Evidence from the Year 2000 systems issue, with Peter Clarkson and Colin Ferguson, *Accounting and Finance*, 2003, 43 (1), 21 – 40.

Working papers

Portfolio rebalancing and mutual fund tournament behavior, with Paul Tacon, Finance and Corporate Governance Conference 2011, FIRN Frontiers in Finance Conference 2011, Financial Management Association Annual Meeting 2012.

The impact of security analyst recommendations on the trading of mutual funds, with David Costello, AFAANZ Conference 2010 (Winner Best Paper in Finance), Australasian Finance and Banking Conference 2010, undergoing revisions for re-submission to *Journal of Contemporary Accounting and Economics.*

Forecasting stock returns using investor flows under short-sales constraints, with Paul Tacon, Australasian Finance and Banking Conference 2011, Finance and Corporate Governance Conference 2012, AFAANZ Conference 2012, Financial Management Association Annual Meeting 2012, Southern Finance Association Annual Meeting 2012.

Presentations

Accounting and Finance Association of Australia and New Zealand Conference (5) 2005, 2007, 2009-10, 2012
Asian Finance Association Conference 2009
Australasian Finance and Banking Conference (2) 2008, 2010
Australian National University Seminar Series 2012
Coal Trade, hosted by AIC Worldwide 1999
Coaltrans Asia, hosted by Coaltrans Conference Limited 1999
Contemporary Accounting Research/Journal of Contemporary Accounting and Economics Joint Symposium 2009
CPA Mining and Energy Conference 2006
Financial Management Association 2012
First Annual Private Equity Conference, hosted by Television Education Network 2007
JBWere Family Business Conference 2010
Melbourne Centre for Consumer Finance Investment & Regulatory Symposium 2008
PhD Conference in Economics and Business, hosted by University of Western Australia 2003
Southern Finance Association 2012
University of Melbourne Seminar Series (2) 2005, 2010
University of Queensland Seminar Series 2008

Referee activity

Accounting and Finance (8 reviews) 2003, 2005, 2009-13
Accounting Research Journal (3 reviews) 2002, 2006, 2010
Applied Financial Economics (3 reviews) 2012-13
Australian Journal of Management 2012
Contemporary Economic Policy 2011
Financial Review 2013
International Journal of Emerging Markets 2013
International Review of Finance 2012
MIS Quarterly 2003
Quarterly Journal of Finance and Accounting 2010
Quarterly Review of Economics and Finance 2012

Research grants

PricewaterhouseCoopers/Accounting and Finance Association of Australia and New Zealand 2006: Returns, tax and volatility – Superannuation choice with a complete information set ($8,500)

Australian Research Council Discovery Grant 2002-4: Quantification issues in corporate valuation, the cost of capital and optimal capital structure ($126,000)

UQ New Staff Research Start-up Fund: The competitive advantage of investments in electronic commerce ($10,000)

Research students

PhD (1 student)

2012 – Paul Tacon

Honours (20 students)

2012 – Edward Parslow (Carnegie Wylie)
2011 – James Lamb (Port Jackson Partners)
2010 – Jeremy Evans (JP Morgan), Sarah Thorne (JP Morgan), Alexandra Dwyer (Reserve Bank of Australia)
2009 – Tristan Fitzgerald (UNSW), David Costello (National Australia Bank), William Toe (Ernst & Young)
2008 – Ben McVicar (Credit Suisse), Matthew Thorne (Credit Suisse)
2007 – Sam Turner (ABN Amro Morgans)
2006 – Paul Tacon (PhD, UQ), Ravi Jeyaraj (Navis Capital), Thomas Green (Crescent Capital), Alexander Pascal-Bossy (Macquarie)
2005 – Angela Gill (Wilson HTM), Andrew Wagner (Macquarie)
2004 – Matthew Tochterman (M. Fin. Eng., UC Berkeley), Justyna Lewandowska (JP Morgan), An Pham (UBS)

Masters (2 students)

2003 – Scott Francis (A Clear Direction Financial Planning), Hernando Barrero (PricewaterhouseCoopers)

PhD reader

Damien Cannavan 2012

Teaching

Ross School of Business, The University of Michigan

Corporate Financial Policy (2008; MBA students; avg. rating 4.3)

UQ Business School, The University of Queensland (Mean teacher ratings out of a possible 5.0)

Awarded undergraduate teaching prize 2009
Empirical Finance Honours (2009-12; PhD and Honours students; avg. rating 4.1)
Corporate Finance Honours (2005 & 2011; PhD and Honours students; avg. rating 4.7)
Investments & Portfolio Management (2002-7, 2009-10 & 2012; B.Com, MBA & M.Com students; avg. rating 3.8)
Corporate Finance (2002-4, 2006-10 & 2012; B.Com, MBA and M.Com students; avg. rating 3.8)
Finance (2005-6; M.Com students; avg. rating 3.7)
Corporate Finance and Investments (Mt Eliza Business School, Beijing 2003; MBA students)
Technology Valuation and Project Evaluation (Singapore 2004; Masters of Technology Management students)
Auditing (Summer 2000/1-2001/2; B.Com, MBA and M.Com students; avg. rating 3.8)

Executive education

Risk Management and Financial Analysis (Rabobank 2000-10)
Financial Analysis of Innovative Investments (UQ Business School 2007)
Credit Analysis (Queensland Treasury Corporation 2005)
Capital Management (UQ Business School 2004)
Making Critical Financial Decisions (UQ Business School 2003)
Business Valuation and Analysis (UQ Business School 2003)
Cost of Capital Estimation (UQ Business School 2003)
Analysis of Real Options (Queensland Treasury 2003)

Student competitions

Rotman International Trading Competition

Manager of the UQ Business School trading team (2007 & 2009-12) which competes annually at the University of Toronto amongst 50 teams. UQ is the 9th most successful entrant from 66 schools which have competed in any of the same years, finishing 3rd in 2010, 6th in 2007, 11th in 2009, 14th in 2011 and 18th in 2012.

UBS Investment Banking Competition

Judge for the UQ section 2006-7 & 2009-12. Faculty representative at the national section 2008.

JP Morgan Deal Competition

Judge for the UQ section 2007-8.

Wilson HTM Research Report Competition

Delivered two workshops as part of the 2006 competition and was one of three judges.

Industry engagement

From 2000-13, I have provided consulting services as part of SFG Consulting and UQBS Commercial. Services have been provided in conjunction with Frontier Economics, ARENA Consulting, Parsons Brinckerhoff and Uniquest.

Retail electricity and gas margins in NSW (Independent Pricing and Regulatory Tribunal 2012)

In 2006-7 and 2009-10 I acted as part of a team which was engaged to estimate electricity costs and margins for electricity and gas retailers in NSW. We have been reappointed for 2012-13. My role related to the estimation of a profit margin which would allow the retailer to earn a return commensurate its systematic risk. The approach developed was novel in that the margin was derived without reference to any pre-defined estimate of the asset base. Rather, the margin was a function of the potential increases or decreases in cash flows which would result from changes in economic conditions. Reports are available from IPART.

Advice on rules to determine regulated rates of return (Australian Energy Markets Commission 2012)

The AEMC is considering changes to the rules relating to regulation of electricity and gas networks. Independent rule change proposals have been put forward by the Australian Energy Regulator and the Energy Users Association of Australia. Both groups argue that application of the existing rules by the regulator generate upwardly-biased estimates of the regulated rate of return. As part of a team I am currently providing advice to the commission on whether the rule change proposals provide evidence on an upward bias, and if so, whether the proposed amendments are likely to reduce the extent of any bias.

Expert evidence relating to regulated rates of return (Electricity network businesses 2011)

In April 2011 the Australian Competition Tribunal heard an appeal by electricity networks on the regulated rate of return set by the Australian Energy Regulator. The issue was the value of dividend imputation tax credits. The Tribunal directed us to perform a dividend drop-off study to estimate the value of a distributed credit. Largely on the basis of our evidence the Tribunal determined that an appropriate value for a distributed credit was 35 per cent of face value. The Tribunal determination is available on its website and our expert report is available on request.

Estimation of risks associated with long-term generation contracts (New South Wales Treasury 2010)

In 2010 the NSW Government privatised a segment of its electricity industry, by selling three electricity retailers and entering into two generation agreements termed GenTrader contracts. The state-owned generators agreed to provide generation capacity in exchange for a charge. The generators also agreed to pay penalties in the event that their availability was less than agreed. As part of a team, I provided advice to NSW Treasury on the risks associated with the contracts. The estimated penalties resulting from this analysis are used by NSW Treasury in their budgeting role and in providing forward-looking analysis to the Government.

Litigation support relating to asset valuation (Alcan 2006-7)

In 2006-7 I acted as part of a team which provided litigation support to Alcan in a dispute with the taxation authority in the Northern Territory. The dispute related to whether Alcan was required to pay stamp duty as a result of its acquisition of an additional 30 per cent interest in Gove Alumina Limited. One issue was whether the acquisition was land-rich, meaning that the proportion of the asset considered to be land exceeded a threshold triggering stamp duty.

Methodology for evaluating public-private partnerships (Queensland Treasury Corporation 2005)

In 2005 I acted as part of a team which advised QTC on evaluating public-private partnerships, which typically require subsidies to appeal to the private sector. We rebutted the conventional wisdom, adopted in NSW and Victoria, that the standard valuation approach is flawed for negative-NPV projects. Furthermore, we developed a technique to incorporate systematic risk directly into expected cash flows, which are then discounted at the risk-free rate.

Litigation support

Insolvency proceedings relating to the collapse of Octaviar (Public Trustee of Queensland 2008-9)
Valuation of resource assets (Compass Resources 2007-8, Westpac Banking Corporation 2007)
Appeals against regulatory determinations (Envestra 2007-8, Telstra 2008)
Advice on whether loan repayments correspond to contract terms (Qld Dept. of Fair Trading 2005)
Advice on whether port and channel assets were contributed and hence not part of regulated assets (Comalco 2004-5)

Valuation

Management performance securities (Collins Foods Group 2006-11, GroundProbe 2008-9)
Ordinary shares in the context of an equity raising (Auscript 2007-8)
Intangible assets (Inbartec 2007)
Resources assets (Senex Energy 2012, Chalco 2007, Bank of Queensland 2007)

Cost of capital estimation, advice and regulatory submissions

Transport (Qantas 2008, QR National 2005 & 2012)
Water (Essential Services Commission of South Australia 2012, ActewAGL 2012, IPART 2011, Metropolitan utilities in Victoria 2004 & 2006-7, QCA 2002-3)
Energy networks (Economic Regulation Authority in Western Australia 2009, Hong Kong Electric 2007, Envestra 2006-7 & 2012, Powercor 2005, AGL 2004, Energex 2003-4, Ergon Energy 2003-4)
Local government networks (Queensland Competition Authority 2009)
Electricity generation (National Generators Forum 2008)
Environmental consulting (Ecowise 2007)
Listed vs unlisted infrastructure funds across alternative European equity markets (ABN AMRO Rothschild 2007)
Forestry assets (Queensland Department of Natural Resources 2004)

Portfolio performance measurement

Performance evaluation and benchmark derivation (Friday Investments 2010-12, Zupp Property Group 2011-12)

Corporate finance

Economic impact assessment of a proposed development of a retail shopping complex (Lend Lease 2006)
Impact of an acquisition on dividend growth, earnings per share and share price (AGL 2003-4)
Estimation of the optimal capital structure for electricity generation and distribution (NSW Treasury 2001-2)
Review of the debt valuation model used by the Snowy Hydroelectric Authority (NSW Treasury 2002)
Estimation of the optimal contract terms for coal sales to an electricity generator (NSW Treasury 2001-2)

Econometrics

Scoping study into the determinants of changes in tax debt in Australia (Australian Taxation Office 2007)

Interests

I am interested in sport as a participant and spectator. I finished 3rd on three occasions in the Brisbane Half Marathon (2005 & 2009-10), 8th in the Toronto Half Marathon (2002) and 3rd in the Australian Universities Marathon Championships (2003). I have finished 17 marathons, recording a best time of 2:47:54 in the Chicago Marathon 2011. From 1994-96 I was a member of The University of Queensland tennis team, which placed 1st at the Australian University Games in 1994.