TransGrid

TransGrid Revenue Proposal
2018/19 – 2022/23

Appendix R

Frontier Economics:

Low Beta Bias

Low-beta bias

REPORT PREPARED FOR TRANSGRID

January 2017

Low-beta bias

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1 Executive summary

1.1 Instructions

1 Frontier Economics has been engaged by TransGrid to provide expert advice in relation to the issue of low-beta bias when estimating the equity beta as part of the implementation of the Sharpe-Lintner CAPM (SL-CAPM).

2 Specifically, we have been asked to:

a. Explain the concept of low-beta bias in the context of the SL-CAPM;

b. Examine the approaches for correcting for low-beta bias;

c. Summarise the evidence about the quantum of low-beta bias; and

d. Provide our opinion about the reasonableness of the AER's approach to correcting for low-beta bias.

1.2 Background and context

3 'Low-beta bias' is the term that is used to summarise one of the main results of empirical tests of asset pricing models – the SL-CAPM systematically under-states the returns on stocks with beta estimates less than one. That is, low-beta stocks systematically earn higher returns than the SL-CAPM would predict – the model does not fit the observable data.

4 Two methods of correcting for low-beta bias have recently been considered in the Australian regulatory setting:

a. Use the Black CAPM (a modification of the SL-CAPM that was developed for the purpose of correcting for low-beta bias) to estimate the required return on equity; or

b. Continue to use the SL-CAPM, but make an adjustment to the equity beta estimate to correct for low-beta bias.

5 In the recent *PIAC-Ausgrid* merits review case,[1] the Australian Competition Tribunal (Tribunal) determined that there is no error in:

a. Recognising the existence of low-beta bias; or

b. Accounting for low-beta bias by making an adjustment to the equity beta estimate in the SL-CAPM.

[1] Applications by Public Interest Advisory Centre Ltd and Ausgrid [2016] ACompT 1.

1.3 Primary conclusions

6 In this report, we explain the concept of low-beta bias and the theoretical rationale for it. We also summarise the evidence and note that low-beta bias is a standard result that is described in the standard textbooks. We examine the methods for correcting for low-beta bias and explain the AER's approach in some detail.

7 We also consider the evidence on the magnitude of low-beta bias and conclude that the majority of studies support an estimate of the zero-beta premium (the additional return, over and above the SL-CAPM forecast, for an asset with a beta of zero) between 2% and 4% and we consider that range to be a reasonable characterisation of the available data. We note that this range is slightly above the range of 1.5% to 3.0% that the AER adopted in its Rate of Return Guideline materials as a range that is "reasonable"[2] and "open to us."[3]

8 Finally, we note that the AER's approach has been to address the evidence of low-beta bias by making an adjustment to the equity beta estimate in the SL-CAPM. The AER's uplift from a best statistical estimate of 0.5 to an allowed beta of 0.7 reflects three considerations, one of which is low-beta bias. We show that even if the entire uplift is attributed to low-beta bias, that would only correct for a low-beta bias of 2.6%, which is at the lower end of the range of empirical estimates.[4] Consequently, we conclude that the AER's approach does not appear to fully correct for low-beta bias. A full correction for the observed low-beta bias would require a greater uplift to the statistical beta estimate than that which the AER has adopted.

1.4 Author of report

9 This report has been authored by Professor Stephen Gray, Professor of Finance at the UQ Business School, University of Queensland and Director of Frontier Economics, a specialist economics and corporate finance consultancy. I have Honours degrees in Commerce and Law from the University of Queensland and a PhD in Financial Economics from Stanford University. I teach graduate level courses with a focus on cost of capital issues, I have published widely in high-level academic journals, and I have more than 20 years' experience advising regulators, government agencies and regulated businesses on cost of capital issues. I have published a number of papers that specifically address beta estimation issues. A copy of my curriculum vitae is attached as an appendix to this report.

10 My opinions set out in this report are based on the specialist knowledge acquired from my training and experience set out above. I have been provided with a copy of the Federal Court's Expert Evidence Practice Note GPN-EXPT, which

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[2] AER Rate of Return Guideline, Explanatory Statement, Appendix C, p. 71.

[3] AER Rate of Return Guideline, Explanatory Statement, Appendix C, p. 71.

[4] We conclude in Section 6 of this report that the majority of the estimates set out above imply a zero-beta premium between 2% and 4% and we consider that range to be a reasonable characterisation of the available data.

comprises the guidelines for expert witnesses in the Federal Court of Australia. I have read, understood and complied with the Practice Note and the Harmonised Expert Witness Code of Conduct that is attached to it.

2 What is low-beta bias?

2.1 Overview

11 Since the AER's 2013 Rate of Return Guideline process, there has been much discussion in the Australian regulatory process about the issue of 'low-beta bias.' This issue has been the subject of numerous submissions, it has been addressed by the AER in its Guideline and in several draft and final decisions, and it was one of the issues raised in the *PIAC-Ausgrid* merits review case.[5]

12 In this report, we explain the concept of low-beta bias and we summarise the empirical and theoretical support for the existence of a systematic low-beta bias. We also document the position that the AER has taken on this point and we summarise the views of the Australian Competition Tribunal.

2.2 The Capital Asset Pricing Model

13 The approach that the AER uses to determine the allowed return on equity is known as the Sharpe-Lintner Capital Asset Pricing Model (SL-CAPM).[6] Under the SL-CAPM, the return on equity that investors would require in the current market conditions, r_e, is given by:

$$r_e = r_f + \beta \times (r_m - r_f)$$

where:

- r_f represents the **risk-free rate** of return. This is the return that is available to investors on an investment that is completely free of risk. Commonwealth government bonds are usually assumed to be such a risk-free investment;
- r_m represents the **expected return on the market**, which is the expected return that investors require to invest in an asset of average risk; and
- $(r_m - r_f)$ represents the **market risk premium**, which is the amount of extra return (over and above the return on a risk-free asset) that investors would require for investing in an asset of average risk; and
- β represents the **equity beta**, which indicates the extent to which the particular investment has more or less risk than average. For example, an equity beta of 1.2 indicates that the investment is 20% more risky than average, in which case it would require a risk premium (over and above the risk-free

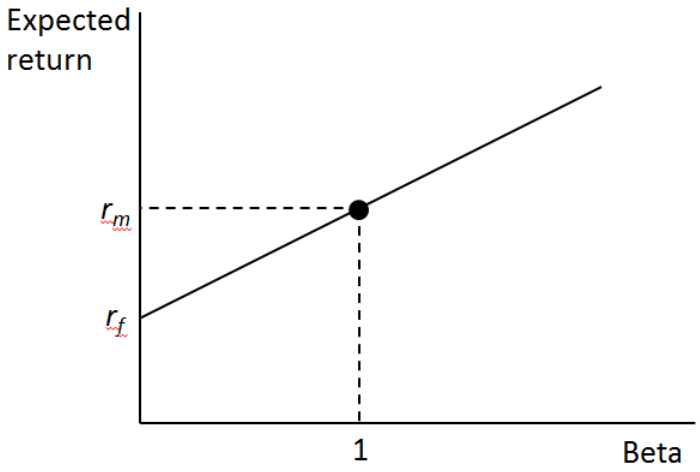
[5] Applications by Public Interest Advisory Centre Ltd and Ausgrid [2016] ACompT 1.

[6] This formula was independently derived by Sharpe (1964) and Lintner (1965). Sharpe, W., 1964, "Capital asset prices: A theory of market equilibrium under conditions of risk," *Journal of Finance,* 19, 425-442; and Lintner, J., 1965, "The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets," *Review of Economics and Statistics,* 13-37.

rate) that is 20% more than would be required for an investment of average risk.

14 The SL-CAPM formula is often displayed in graphical form as in Figure 1 below. This figure shows that firms with higher beta risk require higher expected returns.

Figure 1: Sharpe-Lintner Capital Asset Pricing Model



15 Like all economic models of this type, the SL-CAPM formula was derived by starting with a set of simplifying assumptions and applying a series of mathematical steps to solve for an equilibrium. In the SL-CAPM, the equilibrium pricing formula above is derived by assuming that every investor will trade to maximise their utility (i.e., to obtain the risk/return trade-off that is optimal for them), and by then aggregating over all investors in the market. That is, the SL-CAPM is a theoretical mathematical/economic model that was derived without regard to any market data. Consequently, there is no guarantee that actual market data will be consistent with the predictions of the model.

2.3 The empirical performance of the SL-CAPM[7]

16 Soon after the publication of the Sharpe-Lintner CAPM, researchers began testing whether the predictions (or, more precisely, the empirical implications) of the model were supported in real-world data. The conclusion from this evidence is that the empirical implementation of the SL-CAPM provides a poor fit to the observed data. That is, when the SL-CAPM parameters are empirically estimated and inserted into the SL-CAPM formula, the resulting estimate of the required return on equity bears little resemblance to observed stock returns. The feasible implementation of the SL-CAPM does not fit the observed data. The remainder of this sub-section summarises some of the relevant evidence.

[7] Much of the material in this section is drawn from SFG, 2014, "Cost of equity in the Black Capital Asset Pricing Model," 22 March.

2.3.1 Black, Jensen and Scholes (1972)[8]

17 A number of empirical tests are based on the following rearranged version of the SL-CAPM equation:

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

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

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

19 The SL-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 than the SL-CAPM would suggest $(\gamma_0 > 0)$ and the slope is flatter than the SL-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]

20 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 SL-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 SL-CAPM.

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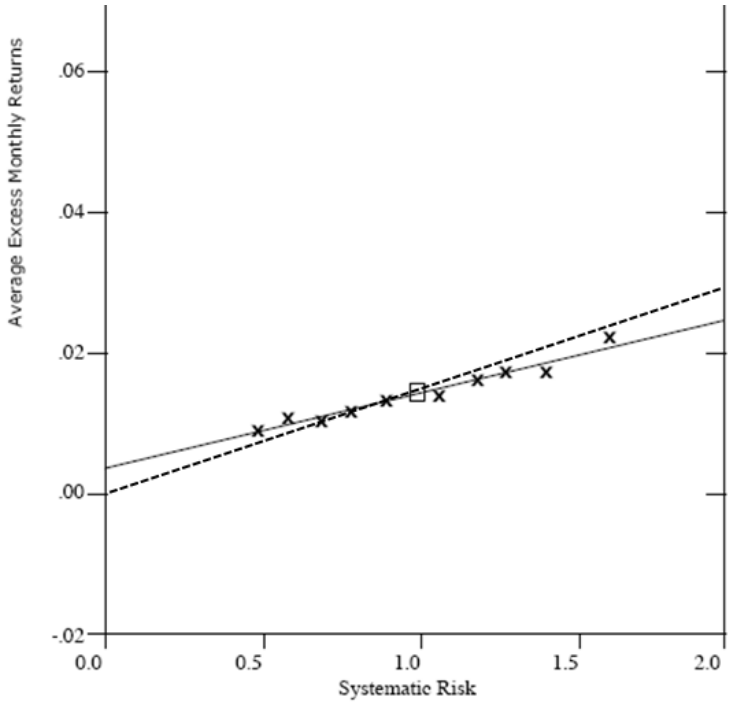
[8] Black, F., M.C. Jensen, and M. Scholes, 1972, "The Capital Asset Pricing Model: Some empirical tests," in *Studies in the Theory of Capital Markets,* Michael C. Jensen, ed., New York: Praeger, 79–121.

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

[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.

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.

21 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:

> 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) [the SL-CAPM] does not provide an accurate description of the structure of security returns.[15]

22 The empirical relationship and the implications of the SL-CAPM are contrasted in Figure 3 below, which shows the SL-CAPM in its usual form. (Note that in Figure

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[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).

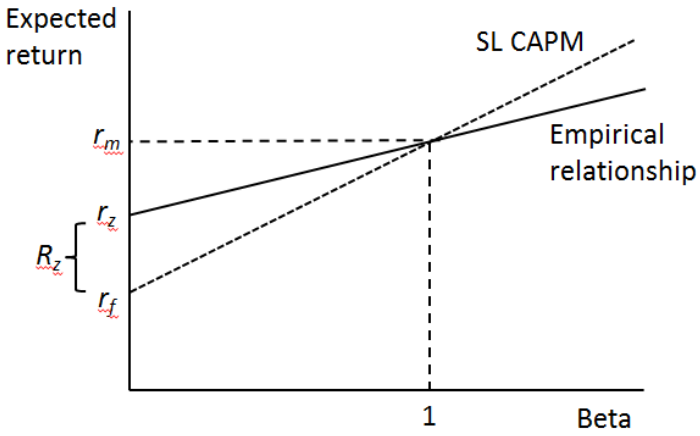
[13] Table 5, p. 38 reports a monthly zero beta premium of 0.338% per month, which is approximately equivalent to 4% per year.

[14] Black, Jensen and Scholes (1972), p. 39.

[15] Black, Jensen and Scholes (1972), pp. 3–4.

2 Black, Jensen and Scholes (1972) show *excess* returns, after subtracting the risk-free rate.)

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



2.3.2 Friend and Blume (1970)[16]

23 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 SL-CAPM:[17]

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

24 Under the SL-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 SL-CAPM would suggest and *high-beta* stocks tend to generate *lower* returns than the SL-CAPM would suggest. This relationship is shown clearly in Figure 4 below. Friend and Blume note that:

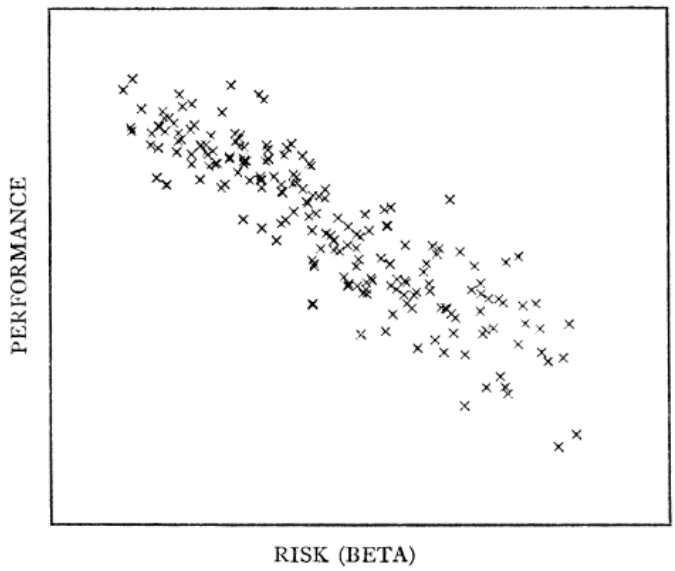
> The absolute values of the performance measures are in excess of market expectations for funds with Beta coefficients below one and below expectations for higher coefficients. [18]

[16] Friend, I., and M. Blume, 1970, "Measurement of portfolio performance under uncertainty," *American Economic Review*, 60, 561–75.

[17] Friend and Blume (1970), p. 563.

[18] Friend and Blume (1970), p. 569.

Figure 4: The relationship between abnormal returns and beta



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

25 Friend and Blume (1970) go on to consider what it is about the SL-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.[19]

2.3.3 Fama and MacBeth (1973)[20]

26 Fama and MacBeth (1973) use the following regression specification:[21]

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

27 Under this specification, the SL-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 SL-CAPM:

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[19] Friend and Blume (1970), p. 569.

[20] Fama, E.F., and J.D. MacBeth, 1973, "Risk, return, and equilibrium: Empirical tests," *Journal of Political Economy*, 81, 607–636.

[21] 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}.[22]

28 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.[23]

2.3.4 Fama and French (2004)[24]

29 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 SL-CAPM would imply and high-beta stocks earn lower returns than the SL-CAPM would imply. With respect to the early tests of the SL-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."

30 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 SL-CAPM, and realised returns on high-beta stocks are lower than predicted by the SL-CAPM. Stocks with the lowest beta estimates (approximately 0.6) had average returns of 11.1% per year, whereas the SL-CAPM estimate of the expected return was only 8.3% per year. Stocks with the highest beta estimates (approximately 1.8) had average returns of 13.7% per year, whereas the SL-CAPM estimate of the expected return was 16.8% per year.

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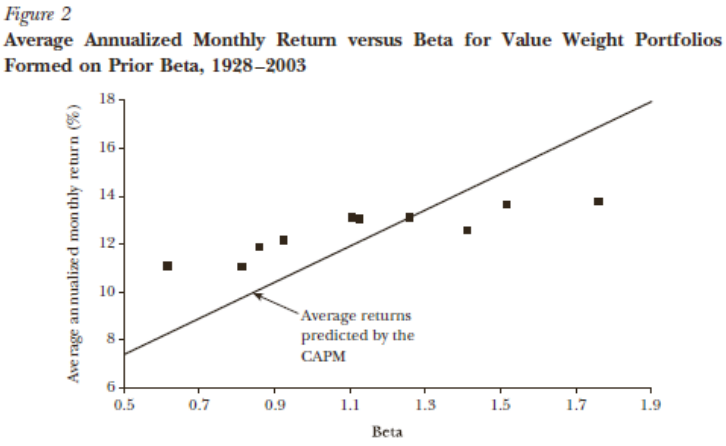
[22] Fama and MacBeth (1973), p. 630.

[23] Fama and MacBeth (1973), p. 632.

[24] Fama, E.F., and K. French, 2004, "The Capital Asset Pricing Model: Theory and evidence," *Journal of Economic Perspectives*, 18, 25–46.

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



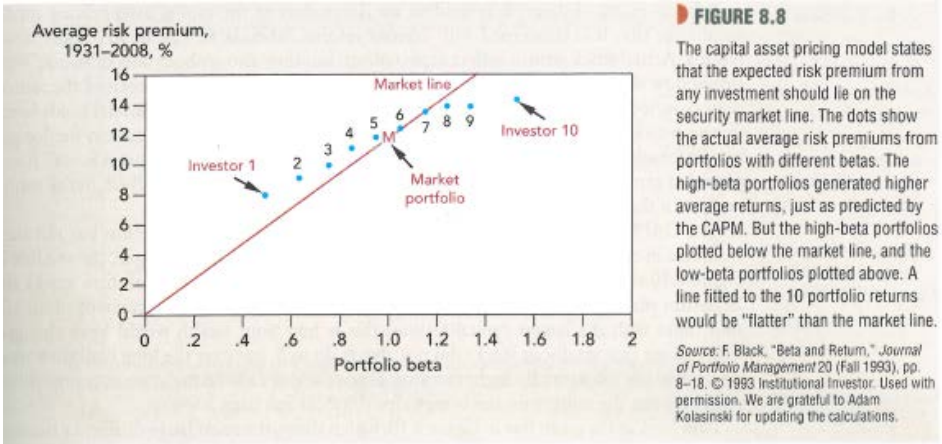
Source: Fama and French (2004), p. 33.

2.3.5 Brealey, Myers and Allen (2011)[25]

31 The evidence of low-beta bias has been so consistent and well-accepted that it is now discussed in standard finance courses and textbooks. For example, Brealey, Myers and Allen (2011), one of the leading finance textbooks, extend the 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 SL-CAPM and each dot represents the observed return for a particular portfolio. Consistent with all of the evidence set out above, the low-beta portfolios still earn higher returns than the SL-CAPM would imply.

[25] Brealey, R.A., S.C. Myers, and F. Allen, 2011, *Principles of Corporate Finance,* 10th ed., McGraw-Hill Irwin.

Figure 6: The relationship between excess returns and beta



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

2.3.6 Berk and DeMarzo (2014)[26]

32 Another leading corporate finance textbook is Berk and DeMarzo (2014). They too consider violations of the SL-CAPM and also the explanations for those violations. They specifically note that if investors are unable to borrow unlimited amounts at the risk-free rate, the empirical relationship that has been documented in the data would be expected to occur. They also note that the result is a relationship between beta and expected returns that has a higher intercept (at r^*) and a flatter slope than the SL-CAPM would imply. They conclude that:

> Because our determination of the security market line depends only on the market portfolio being tangent for some interest rate, the SML still holds in the following form:
>
> $$E[R_i] = r^* + \beta_i\left(E[R_{Mkt}] - r^*\right)$$
>
> That is, the SML holds with some rate r^* in place of r_f.[27]

2.3.7 Summary of the empirical evidence

33 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 SL-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 SL-CAPM; and

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

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[26] Berk, J. and P. DeMarzo, 2014, *Corporate Finance,* 3rd global ed., Pearson.

[27] Berk and DeMarzo (2014), p. 399.

2.4 Systematic low-beta bias

34 The evidence set out above suggests that the actual relationship between beta and stock returns has a flatter slope than the SL-CAPM predicts. The result of this is that:

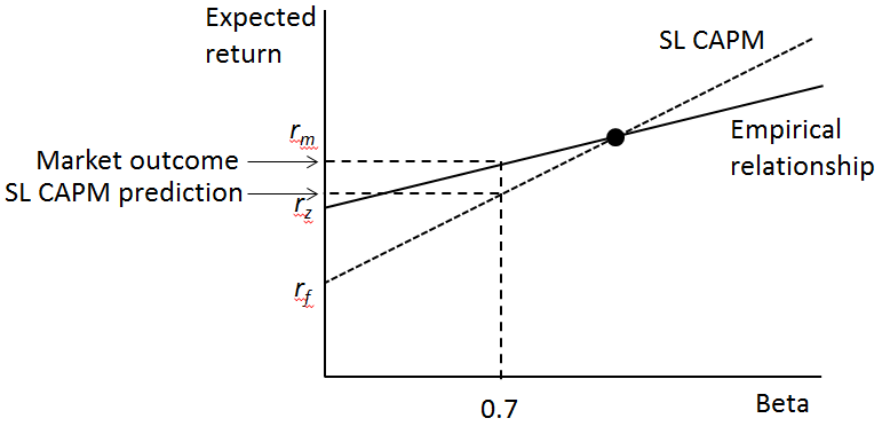
a. The SL-CAPM systematically underestimates the required return on low-beta stocks (i.e., those with a beta estimate less than 1); and

b. The SL-CAPM systematically overestimates the required return on high-beta stocks (i.e., those with a beta estimate more than 1); and

c. The magnitude of the bias is greater when the beta estimate is further away from 1.

35 In the regulatory setting, the focus has been on stocks with a beta less than 1, because regulators tend to consider the infrastructure firms that they regulate to have lower than average systematic risk. Figure 7 below shows that for stocks with a beta less than 1, the SL-CAPM consistently underestimates actual stock returns. This empirical result is known as the 'low-beta bias.'

Figure 7: Sharpe-Lintner CAPM vs. empirical relationship.



3 The theoretical rationale for low-beta bias

36 As set out above, the empirical tests of the SL-CAPM have consistently indicated that the relationship between equity beta and stock returns tends to be flatter than the SL-CAPM would suggest.[28] Black (1972)[29] summarises some of this literature as follows:

> …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).[30]

37 In trying to develop a conceptual rationale for this observed and consistent empirical finding, Black (1972) focuses on one of the assumptions that underpins the derivation of the SL-CAPM – that all investors can borrow or lend as much as they like at the risk-free rate. He 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.[31]

38 That is, Black (1972):

a. Notes that there is consistent evidence about the empirical failings of the SL-CAPM; and

b. Augments the SL-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 SL-CAPM.

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

[29] Black, F., 1972, "Capital market equilibrium with restricted borrowing," *Journal of Business*, 45, 3, 444-455.

[30] Black (1972), p. 445.

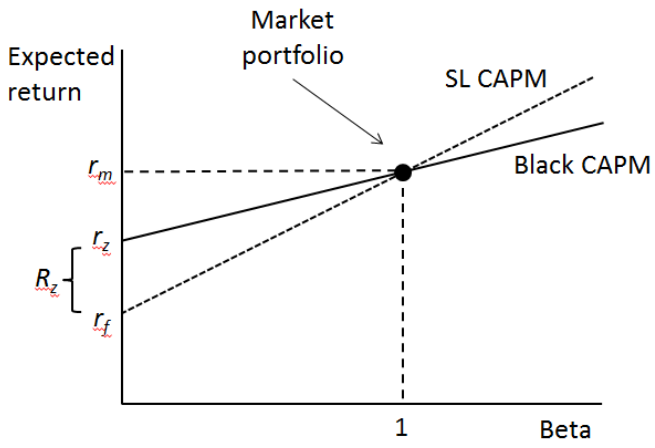
[31] Black (1972), p. 445.

39 Specifically, Black relaxes the SL-CAPM assumption that all investors can borrow or lend unlimited amounts at the risk-free rate, and derives a modified version of the CAPM that has become known as the 'Black CAPM.' The specification of the Black CAPM is as follows:

$$r_e = r_z + \beta(r_m - r_z)$$

where r_z is the new intercept term, which is above the risk-free rate by an amount R_z, which is known as the 'zero-beta premium.' This model is contrasted against the SL-CAPM in Figure 8 below. The figure shows that the Black CAPM, which is a theoretically derived model based on a modified set of assumptions, produces predictions that conform more closely to the observed empirical evidence.

Figure 8: The Black CAPM



40 That is, there are two models that have been theoretically derived from different sets of assumptions. One has predictions and empirical implications that are consistent with the observed data and the other does not.

4 How to correct for low-beta bias

41 Two methods of correcting for low-beta bias have recently been considered in the Australian regulatory setting:

a. Use the Black CAPM to estimate the required return on equity since that model does not suffer from low-beta bias (indeed the documentation of low-beta bias was the original motivation for its derivation); or

b. Continue to use the SL-CAPM, but make an adjustment to the equity beta estimate to correct for low-beta bias.

42 We illustrate these two approaches via a simple numerical example that is based on the following parameters:

a. Equity beta of 0.4;[32]

b. Market risk premium of 6% (in which case the required return on the market is 10%);

c. Risk-free rate of 4%; and

d. Zero-beta premium of 3% (in which case the intercept term for the Black CAPM is 7%).

43 For this example, the SL-CAPM suggests that the required return on equity is given by:

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

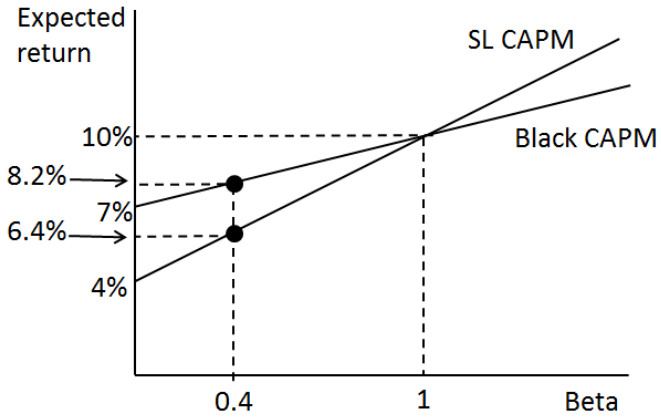
and the Black CAPM suggests that the required return on equity is given by:

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

44 The SL-CAPM estimate suffers from low-beta bias, but the Black CAPM estimate does not. This is illustrated in Figure 9 below. Thus, one way to avoid low-beta bias is to use the Black CAPM rather than the SL-CAPM.

[32] These parameters are drawn from the AER's Rate of Return Guideline, Explanatory Statement, Appendix C, Table C.11, p. 71.

Figure 9: Comparison of SL-CAPM and Black CAPM estimates



Source: Frontier Economics calculations.

45 The alternative approach is to pose the question: What beta, when inserted into the SL-CAPM, would produce an estimate of required return of 8.2% so as to be consistent with the evidence from the Black CAPM? Figure 10 below shows that the relevant modified 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 evidence.

46 The logic behind these calculations can be summarised as follows:

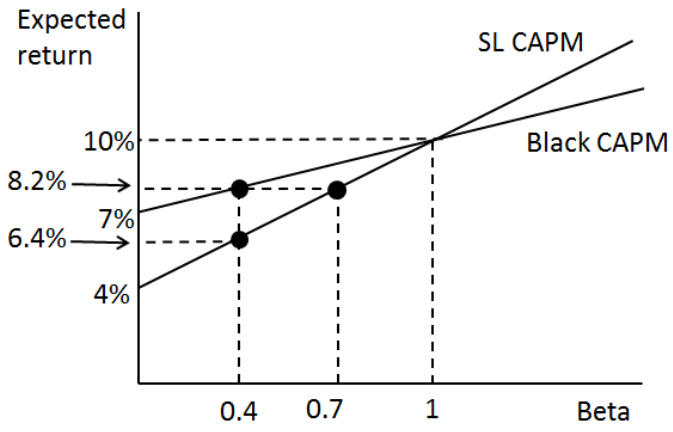
a. Beta is estimated to be 0.4;

b. It is recognised that the theoretical and empirical evidence establishes that if this beta estimate is inserted into the SL-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%; and

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

Figure 10: Modifying the SL-CAPM to correct for low-beta bias



Source: Frontier Economics calculations.

47 In summary, there are two ways to correct for the low beta bias in this case:

a. Estimate the parameters of the Black CAPM and insert those parameters into the Black CAPM formula; or

b. Continue to use the SL-CAPM formula, but use an increased beta estimate that is calibrated to offset the bias that arises from applying the SL-CAPM to low-beta stocks.

48 If the adjustment to the beta estimate under the second approach is consistent with the estimate of the zero-beta premium that is required for the first approach, the estimates of the required return on equity will be the same under both approaches.

5 The AER's approach to low-beta bias

5.1 The AER's 2013 Rate of Return Guideline

49 In its 2013 Rate of Return Guideline materials, the AER stated that it will account for the evidence of low-beta bias in the context of the Black CAPM.[33] 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.[34]

50 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 SL-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.[35]

51 The AER also states that:

> A key outworking of the Black CAPM is that the Sharpe–Lintner CAPM may underestimate the return on equity for firms with equity betas less than one.[36]

52 The AER goes on to state that it will not estimate the Black CAPM, but rather that it will have regard to the evidence of low-beta bias and the Black CAPM when selecting a beta estimate to insert into its SL-CAPM formula:

> …using the Black CAPM theory to inform our equity beta estimate may mitigate possible low beta bias…we consider this represents a pragmatic approach.[37]

53 That is, the AER recognises the existence of low-beta bias and states that it will adopt the second of the two approaches set out above to correct for it.

54 The AER then goes on to demonstrate how the equity beta can be adjusted to correct for low beta bias. To do this, the AER sets out six worked numerical examples in its Guideline materials.[38] The first of the AER's examples uses the figures that are the basis of the numerical example in the previous section of this report. The AER shows that, for a zero-beta premium of 3%, an equity beta of

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[33] AER, 2013, Rate of Return Guideline, p. 13.

[34] AER, 2013, Rate of Return Guideline, Explanatory Statement, p. 85.

[35] AER,2013, Rate of Return Guideline, Explanatory Statement, Appendix A, p. 17.

[36] AER, 2013, Rate of Return Guideline, Explanatory Statement, Appendix A, p. 18.

[37] AER, 2013, Rate of Return Guideline, Explanatory Statement, Appendix A, p. 12.

[38] AER, 2013, Rate of Return Guideline, Explanatory Statement, Appendix C, Table C.11, p. 71.

0.4 would have to be adjusted to 0.7 to account for low-beta bias – as in the example above.

5.2 The AER's recent final decisions

55 In its recent final decisions,[39] the AER has maintained the position set out in its Guideline insofar as it recognises the Black CAPM/low-beta bias evidence and makes an adjustment in relation to this evidence to the equity beta that is used in the SL-CAPM:

> The theoretical principles underpinning the Black CAPM demonstrate that market imperfections could cause the true (unobservable) expected return on equity to vary from the Sharpe-Lintner CAPM estimate. This is a result of slightly different starting assumptions between the models. The resulting variation in expected return on equity is (in the theoretical principles) larger for businesses with equity betas further from one. We have also considered the empirical evidence that the Sharpe-Lintner CAPM tends to underestimate returns on low beta stocks when examined using ex-post data.
>
> Our empirical and conceptual analysis of equity beta for businesses with a similar degree of risk as JEN (in the provision of regulated services) indicates an equity beta less than one, and within the range of 0.4 to 0.7. In this case, where initial considerations indicate an equity beta materially below one, the theory of the Black CAPM may be relevant. As the importance of the theory of the Black CAPM is relative to considerations of the business' equity beta estimate, we consider it is appropriate for the theory of the Black CAPM to inform our equity beta estimate.[40]

56 In its recent Final Decisions, the AER states that its "best empirical estimate" of beta is 0.5:

> We consider the evidence in Henry's 2014 report suggests a best empirical estimate for the equity beta of approximately 0.5.[41]

Thus, the AER has stated that its 'starting point' beta estimate is 0.5.

57 The AER goes on to state that its final allowed beta is 0.7.[42] The uplift from 0.5 to 0.7 is said to be based on three considerations:

a. "International estimates" [43] – due to the fact that the weight of evidence from international comparators supports a beta estimate materially above the AER's domestic starting point estimate;

b. "Considerations of the Black CAPM"[44] – due to the fact that the Black CAPM evidence is that the unadjusted SL-CAPM will

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[39] AER, 2016, Final Decision: Jemena distribution determination 2016 to 2020, May.

[40] JEN Final Decision, 2016, Attachment 3, p. 191.

[41] JEN Final Decision, 2016, Attachment 3, p. 64.

[42] JEN Final Decision, 2016, Attachment 3, p. 64.

[43] JEN Final Decision, 2016, Attachment 3, p. 64.

[44] JEN Final Decision, 2016, Attachment 3, p. 64.

systematically understate the required return on low-beta stocks; and

c. "Investor certainty"[45] – due to the fact that a larger movement from the AER's previous 0.8 allowance may cause investors to increase their assessment of regulatory risk.

58 Nowhere in its decisions does the AER quantify how much of the uplift from 0.5 to 0.7 is due to each of the three factors that it has documented. Moreover, the AER has not stated whether it considers any of the three factors to be more or less important than the others.

59 In our view, because there is no way of knowing what uplift was applied in relation to each of the three factors, there is no way of knowing whether or not the uplift that was applied in relation to a factor, if any, was reasonable.

5.3 The Tribunal's considerations of low-beta bias

60 The Australian Competition Tribunal has recently considered the issue of low-beta bias, and the adjustments that may be made to correct for it, in the *PIAC-Ausgrid* case.[46] In those proceedings, the Public Interest Advisory Centre (PIAC) submitted that the AER had erred in making any uplift at all to its starting point equity beta estimate of 0.5. However, the Tribunal concluded that there was no error in concluding that there was evidence of low-beta bias and that there was no error in making an uplift to the equity beta in relation to that evidence.

61 In response to PIAC's submission that there was no evidence of low-beta bias that would justify the AER departing from its starting point beta of 0.5, the Tribunal concluded that:

> Upon reviewing the whole of the material before the AER, the Tribunal however is not satisfied that that material does not support a conclusion that the SL CAPM provided a low equity beta bias.[47]

62 In relation to the evidence of low-beta bias, the Tribunal concluded as follows:

> It is, as the AER noted, correct that the three parameters for the SL CAPM – equity beta, risk free rate, and MRP – are recorded as giving a low beta bias for businesses with a beta (that is, the risk of the asset relative to the average asset) of less than 1.0, and that the Network Applicants are all within that group. There was also evidence that the low beta bias is exacerbated when it is combined with conditions of low government bond rates and a high MRP. Those conditions were applicable at the time of the AER Final Decisions.[48]

63 That is, the Tribunal accepted the existence of low-beta bias – that the SL-CAPM systematically understates the returns of low-beta stocks.

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[45] JEN Final Decision, 2016, Attachment 3, p. 64.

[46] Applications by Public Interest Advisory Centre Ltd and Ausgrid [2016] ACompT 1.

[47] *PIAC-Ausgrid*, 2016, Paragraph 779.

[48] *PIAC-Ausgrid*, 2016, Paragraph 731.

64 The Tribunal summarised the detail of the PIAC submission as follows:

> PIAC criticises the AER's view that the Black CAPM would be expected to warrant an upward adjustment (of some unspecified magnitude) to the best empirical estimates derived in accordance with the SL CAPM. That, it says, is found in the Final Decisions and in the RoR 2013 Guideline.
>
> PIAC says the analysis of the AER to justify that approach is an exercise in econometric reverse-engineering; and was to assess whether the AER might be able to justify making an adjustment from any point within the 0.4-0.7 range to the upper bound of that range.[49]

65 The Tribunal then determined that there is no error in:

a. Recognising the existence of low-beta bias; or

b. Accounting for low-beta bias by making an adjustment to the equity beta estimate in the SL-CAPM.

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[49] *PIAC-Ausgrid*, 2016, Paragraphs 774-775.

6 Evidence of the magnitude of low-beta bias

Grundy (2010)

66 In the Australian regulatory setting, the first evidence of the magnitude of low beta bias was provided by Grundy (2010).[50] His summary of the relevant evidence is reproduced as Table 1 below.

Table 1: Summary of evidence from Grundy (2010)

Paper	Sample period		(Rm-R0)/ (Rm-Rf)
Empirical papers cited by the AER			
Schrimpf, Schroder and Stehle (2007)	1969-2002	Estimate of Rm-R0=0.2% per month. Note that an annual MRP of 6.5% implies a monthly MRP of 0.54% per month	N/A
Ang and Chen (2007)	1926-1963:06	Cannot reject the Sharpe CAPM	N/A
	1963:07-2001	Likelihood the Sharpe CAPM is true is <1%	N/A
Gruaer and Janmaat (2010)	1963-2005	For 7 of the 14 methods for grouping stocks to form portfolios that are examined in the paper, the likelihood of the Sharpe CAPM being true is <5%	N/A
Gregory and Michou (2009)	1975-2005	Examines 35 industries. For only 3 industries would one reject the Sharpe CAPM at the 5% level. For the Gas, Water and Multi-utility industry, returns are statistically significantly higher at the 5% level than predicted by the Sharpe CAPM	N/A
Black (1993)	1926-1965	Likelihood Sharpe CAPM true <1%	N/A
Schwert (2003)	1926-1965	Likelihood Sharpe CAPM true <0.0001%	N/A
Morana (2009	1965-2001	Likelihood Sharpe CAPM true <1%	N/A
Daniel, Titman and Wei (2001)	1975-1997	Likelihood Sharpe CAPM true <0.34%	N/A
Da, Guo and Jagannathan (2009)	1932-2007	Likelihood Sharpe CAPM true <0.002%	0.232
Kothari, Shanken and Sloan (1995)	1927-1990	Likelihood Sharpe CAPM true <0.058%	0.415
Classic tests of the Sharpe CAPM			
Fama and Macbeth (1973)	1935-1968	Likelihood Sharpe CAPM true <0.55%	0.639
Black, Jensen and scholes (1972)	1931-1965	Likelihood Sharpe CAPM true <0.0001%	0.761
Average			**0.511**

Source: Grundy (2010), Table 1, p. 13.

[50] Grundy, B., 2010, "The calculation of the cost of capital: A report for Envestra," 30 September.

67 The relevant evidence from Table 1 is the estimates of $\frac{R_m - R_0}{R_m - R_f}$, which can be interpreted as the ratio of the slope of the empirical relationship between beta and returns and the slope of the SL-CAPM. An estimate below 1 indicates that the actual data exhibits a flatter slope than the SL-CAPM implies – consistent with low-beta bias.

68 This estimate of the ratio of the slopes can be converted into an estimate of the zero-beta premium (i.e., the extent to which the actual empirical intercept is above the risk-free rate as in Figure 8 above) as follows:

$$R_z = \left(1 - \frac{R_m - R_0}{R_m - R_f}\right) \times MRP.$$

69 Thus, for an MRP of 6.5%, the mean slope ratio estimate of 0.511 would imply a zero-beta premium of:

$$R_z = (1 - 0.511) \times 6.5\% = 3.2\%.$$

70 That is, the empirical estimate of the intercept in the relationship between beta and stock returns is 3.2% above the risk-free rate.

71 The more recent estimates in Table 1 imply higher zero-beta premiums:

a. Kothari, Shanken and Sloan (1995)[51] implies a zero-beta premium of 3.8%; and

b. Da, Guo and Jagannathan (2009)[52] implies a zero-beta premium of 5.0%.

Davis (2011)

72 In a report for the AER, Davis (2011)[53] considers the results of Kothari, Shanken and Sloan (1995) in more detail. Specifically, he makes an adjustment to the way Grundy (2010) had estimated the relative slope,[54] and he considers the full range of data sorts rather than just the main sort that had been considered by Grundy.[55] Davis concludes that the estimate of the zero-beta premium varies depending on how the various portfolios are constructed and according to which time period is used.

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[51] Kothari, S. P., j. Shanken and R. Sloan, 1995, "Another look at the cross section of expected stock returns, *Journal of Finance*, 50, 1, 185-224.

[52] Da, Z., R. Guo and R. Jagannathan, 2009, "CAPM for estimating the cost of equity capital: Interpreting the empirical evidence, NBER Working Paper 14889.

[53] Davis, K., 2011, Cost of equity issues: A further report for the AER, May 13.

[54] By dividing the reported annual risk-free rate by 12 to make it consistent with the monthly units of other parameters.

[55] The approach of these studies is to form a set of portfolios and then plot the relationship between beta and returns for the set of portfolios. The portfolios can be formed on the basis of beta estimates from a prior period, or size, of industry, or some combination of these characteristics.

73 We summarise the estimates for all portfolio formation methods and for both of the data periods considered by Kothari, Shanken and Sloan (1995) in Table 2 below. The table shows that the zero-beta premium ranges from about 2% to over 4%, except for one portfolio sort for one time period where the zero-beta premium was immaterial.

Table 2: Zero-beta premium estimates from Kothari, Shanken and Sloan (1995)

Method	Zero-beta premium
1927-1990	
Ranked on beta	3.0%
Ranked on size	0.0%
Ranked on beta and size independently	2.2%
Ranked on beta then size	1.8%
Ranked on size then beta	1.8%
1941-1990	
Ranked on beta	4.7%
Ranked on size	2.7%
Ranked on beta and size independently	4.4%
Ranked on beta then size	4.1%
Ranked on size then beta	4.0%

Source: Kothari, Shanken and Sloan (1995), Table I, pp. 196-197; Frontier Economics calculations.

74 Davis (2011) also considers the estimates for various 5-year sub-periods in the earlier Fama and Macbeth (1973)[56] study, and notes that the estimates vary across periods. However, such variation is entirely expected since a 5-year period is extremely short when seeking to estimate the slope of the security market line. Indeed, the slope of the line for the SL-CAPM is the MRP. It is not at all surprising that the results are unstable when estimates are based on only 5 years of data.

NERA (2013)

75 NERA (2013)[57] demonstrate that, for the Australian data between 1974 and 2012, there is no relationship at all between beta estimates and stock returns. Their results are reproduced in Figure 11 below. NERA form 10 portfolios by ranking

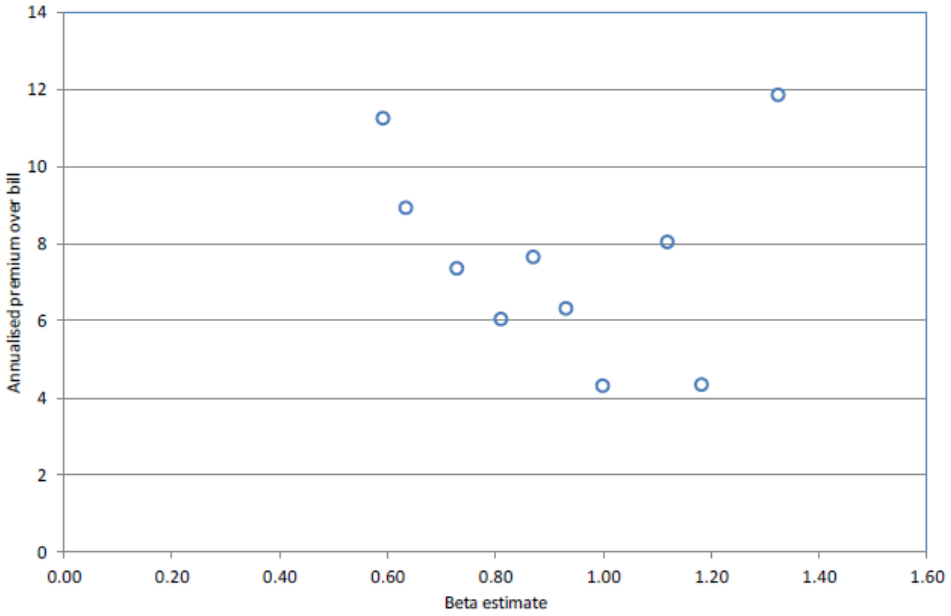
[56] Fama, E., and J. Macbeth, "Risk, return, and equilibrium: Empirical tests," *Journal of Political Economy*, 81 (3), 1973, pp. 607-636.

[57] NERA, 2013, Estimates of the zero-beta premium, June.

stocks based on their beta estimates. Thus the 10% of firms with the lowest beta estimates are assigned to the first portfolio and so on. The portfolio beta is then graphed against the subsequent annual returns of the portfolio. The figure below shows that the portfolios with the lowest betas produce returns that are among the highest of all portfolios.

Figure 11: NERA (2013) results

Figure 5.1
Annualised premium over bill against beta estimate for 10 portfolios formed on past beta estimates



Notes: Data are from SIRCA's SPPR database. Annualised premium is in per cent and is the monthly premium multiplied by 12. Estimates are computed using data from 1974 to 2012.

Source: NERA (2013), Figure 5.1, p. 15.

76 The fact that there is no discernible relationship between beta estimates and stock returns means that the empirical security market line is not significantly different from a horizontal line. That is, beta estimates cannot be used to determine whether a stock is likely to generate above- or below-average returns. NERA (2013) conclude:

> The fact that estimates of the zero-beta premium do not differ significantly from the values that the AER has chosen in the recent past for the *MRP* is consistent with the evidence that Figure 5.1 provides that there is little relation across stocks between risk, measured by an estimate of beta, and return.[58]

77 This implies that the required return for any stock would be set equal to the estimate of the required return on the market – the sum of the risk-free rate and the MRP.

[58] NERA (2013), p. 16.

SFG (2014)

78 The most recent Australian estimate of the zero-beta premium is that of SFG (2014).[59] SFG (2014) recognise that the non-relationship between beta estimates and stock returns in the Australian market is driven by two things:

a. In the Australian market, value stocks (those with a high book-to-market ratio) tend to have low beta estimates and these stocks are well-known to have generated returns in excess of the SL-CAPM predictions; and

b. After controlling for the out-performance of value stocks, there remains a low-beta bias.

79 SFG (2014) note that any bias associated with the book-to-market ratio would be accommodated by the Fama-French model (FFM), whereas the low-beta bias would be accommodated by the Black CAPM. That is, any outperformance of the SL-CAPM prediction that is due to the fact that the stock has a high book-to-market ratio would be accommodated via the FFM, so there is a need to estimate the degree of outperformance that occurs simply because the stock has a low beta. Thus, the SFG approach is to control for any book-to-market effect so as to isolate the effect that arises simply because a stock has a low beta.

80 The econometric approach used by SFG (2014) is set out in detail in their report. Their conclusion is that the best available point estimate of the zero-beta premium is 3.34%.

81 In its recent final decisions, the AER has stated that:

> We consider SFG's latest estimate of the zero beta premium appears more plausible, as it is not negative and is below the market risk premium.[60]

Summary and conclusion

82 The majority of the estimates set out above imply a zero-beta premium between 2% and 4% and we consider that range to be a reasonable characterisation of the available data.

83 We note that this range is slightly above the range of 1.5% to 3.0% that the AER adopted in its Rate of Return Guideline materials. In its Guideline, the AER stated that:

> …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,[61]

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[59] SFG, 2014, Cost of equity in the Black Capital Asset Pricing Model, May.

[60] JEN Final Decision, Attachment 3, p. 185.

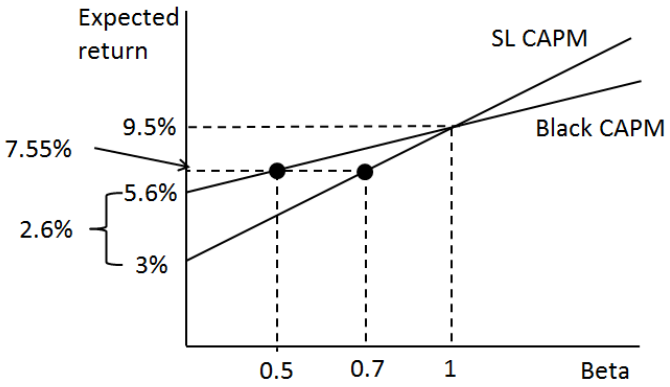
[61] AER Rate of Return Guideline, Explanatory Statement, Appendix C, p. 71.

and:

> this magnitude of adjustment appears open to us.[62]

84 Figure 12 below demonstrates that a beta uplift from 0.5 to 0.7 would be consistent with a zero-beta premium of 2.6%. That is, if the AER's entire uplift was due to low-beta bias, it would correct a zero-beta premium of 2.6%, which is at the lower end of the reasonable range.

Figure 12: AER parameter estimates in the context of the Black CAPM



Source: Parameters from JEN Final Decision, 2016, Attachment 3, p. 12; Frontier Economics calculations.

85 For the reasons set out above, we conclude that the AER's approach does not appear to fully correct for low-beta bias. A full correction for the observed low-beta bias would require a greater uplift to the statistical beta estimate than that which the AER has adopted.

[62] AER Rate of Return Guideline, Explanatory Statement, Appendix C, p. 71.

7 Declaration

86 I confirm that I have made all the inquiries that I believe are desirable and appropriate and no matters of significance that I regard as relevant have, to my knowledge, been withheld from the Court.

Professor Stephen Gray

8 Appendix: Instructions

TransGrid

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Professor Stephen Gray
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27 January 2017

Dear Stephen

Expert Advice on Rate of Return and Value of Imputation Credits

TransGrid is preparing its revenue proposal for the 2018/19 to 2022/23 regulatory period. To assist TransGrid in the preparation of the proposal, TransGrid seeks advice on the following matters from a suitably qualified expert. The advice should be in the form of an expert report that complies with the Federal Court's Expert Evidence Practice Note GPN-EXPT.

In relation to the estimation of the **market risk premium**, the expert is asked to:

a. Explain where the estimation of the MRP fits within the AER's regulatory framework;

b. Explain the approach to estimating the MRP that the AER set out in its 2013 Rate of Return Guideline;

c. Summarise the evolution of the relevant evidence and empirical estimates since 2013;

d. Explain the implications of applying a constant, or substantially constant, MRP to contemporaneous estimates of the MRP; and

e. Provide a current estimate of the MRP by applying the approach set out in the AER's 2013 Rate of Return Guideline to the updated evidence.

In relation to the estimation of the **equity beta** for the benchmark efficient entity, the expert is asked to:

a. Provide an updated set of estimates of equity beta using the current set of listed comparators that the AER uses to set its primary range for beta;

b. Provide a current set of beta estimates for other listed infrastructure firms that operate in workably competitive markets; and

c. Consider the implications of the updated estimates in (a) and (b) above for the AER's current equity beta allowance of 0.7.

In relation to **low-beta bias**, the expert is asked to:

a. Explain the concept of low-beta bias in the context of the SL-CAPM;

b. Examine the approaches for correcting for low-beta bias;

c. Summarise the evidence about the quantum of low-beta bias; and

d. Provide your opinion about the reasonableness of the AER's approach to correcting for low-beta bias.

In relation to the estimation of **gamma**, the expert is asked to:

a. State their views about whether gamma should be interpreted in terms of the market value of imputation credits or in terms of the proportion of credits that are available to be redeemed;

b. Having regard to the answer to (a) above, provide their opinion about what is the best currently available empirical estimate of gamma and of each component of gamma, the distribution rate and the value of distributed credits, theta;

c. State their views about the econometric issues that the AER has raised and maintained in relation to dividend drop-off analysis; and

d. State their views of the issues raised in the Lally (2016) report commissioned by the AER (Lally, M., 2016, "Gamma and the ACT decision," 23 May).

In relation to **dividend drop-off estimation of gamma**, the expert is asked to:

a. Update the SFG (2013) dividend drop-off analysis to incorporate more recent data. (SFG, 2013, "Updated Dividend drop-off estimate of theta," report for the Energy Networks Association, 7 June).

In relation to **transition arrangements for the allowed return on debt**, the expert is asked to provide a short note in letter form that:

a. Sets out the appropriate economic framework for considering whether a transition period should be used when moving to the trailing average approach to the allowed return on debt; and

b. Apply that framework to the benchmark efficient entity and draw conclusions about the economic rationale for the AER's proposed 10-year transition.

Yours sincerely

Nicola Tully
Manager / Prescribed Revenue and Pricing

9 Appendix: Curriculum Vitae of Professor Stephen Gray

Stephen F. Gray

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Director
Frontier Economics
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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

2014 E Yetton Prize for best paper in the Australian Journal of Management, Brailsford, T., S. Gray and S. Treepongkaruna, (2013), "Explaining the bid-ask spread in the foreign exchange market: A test of alternate models."
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)

- Institute of Teaching and Learning Innovation Grant 2016-17, Technology-enhanced Learning Grant ($200,000), with K. Benson, B. Oliver and J. Birt.

- 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

Gray, S. and D. Morrison, (2017), 'Phoenixing at the fulcrum: Less faff, faster forward formulation," *Insolvency Law Journal*, forthcoming.

Gray, S. and J. Nowland, (2016), Director workloads, attendance and firm performance, *Accounting Research Journal*, forthcoming.

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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

2012 - Present: Director, Children's Hospital Foundation, Queensland.

2002 - Present: Director, Financial Management Association of Australia Ltd.
2003 - 2012: Director, Moreton Bay Boys College Ltd. (Chairman from 2007).
2002 - 2007: External Risk Advisor to Board of Enertrade (Queensland Power Trading Corporation Ltd.)

Consulting

SFG Consulting: 1997-2014.
Frontier Economics: 2014-Present.

Twenty years' experience in consulting to companies, government-owned corporations, government and regulatory agencies. Examples include:

- *Regulatory cost of capital*: Preparation of submissions in regulatory determinations. Clients include all Australian energy transmission and distribution businesses, FOXTEL, Telstra, BBI, ACCC, IPART, ERA.

- *Corporate cost of capital reviews*: Review of cost of capital estimates for project evaluation and impairment testing purposes. Clients include QANTAS, Stanwell Corporation, Ecowise.

- *Executive stock option valuation*: Clients include Collins Foods Group, Ground Probe, Crater Gold Mining, Beach Petroleum.

- *New Project Evaluation*: Assisting companies and GOCs to evaluate proposed new projects. Particular focus is on quantifying risk and uncertainty and presenting possible outcomes in a probabilistic framework. Clients include Queensland Treasury Corporation, Queensland Accommodation Group, Stanwell, EnerTrade.

- *Financial modelling and forecasting*: Clients include ATO (forecasting delinquent payments), ASX (forecasting trading volumes), Compass Resources (integrated mine valuation model).

Retained as a valuation expert in many litigation cases; produced many expert witness reports; appeared in Court for cross examination many times including:

- *Macquarie Generation*: Witness for AGL in competition case.
- *Telstra v. ACCC*: Witness for Telstra in rate of return regulation case.
- *C7 Case*: Witness for PBL, Newscorp, Telstra re valuation of Seven's failed cable TV network.
- *Alcan v. NT Commissioner of Revenue*: Witness for Alcan re valuation of combined bauxite mine and alumina refinery for stamp duty purposes.

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