Low-beta bias and the Black CAPM

REPORT PREPARED FOR ENERGY NETWORKS AUSTRALIA

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1 Executive summary

1.1 Instructions

1 Frontier Economics has been engaged by Energy Networks Australia to provide expert advice in relation to the issue of the role of low-beta bias and the Black CAPM when estimating the equity beta as part of the implementation of the Sharpe-Lintner CAPM (SL-CAPM) in the context of the Australian Energy Regulator's (AER's) Foundation Model approach to setting the allowed return on equity.

2 Specifically, we have been asked to perform the following tasks:

a. A review of the literature as to whether low beta bias exists and what grounds (if any) there are for concluding that it does exist based on theoretical reasoning, expected returns (or ex-ante expectations), and/or ex-post returns, and the relative strengths of those various sources of information.

b. Based upon the best evidence available, and in light of the AER's consideration and discussion of low beta bias in the Draft Guideline process, whether any low beta bias is statistically different from zero.

c. Given consideration of the above questions, whether it is reasonable for a regulator to give no weight to any potential low beta bias when estimating equity beta.

1.2 Primary conclusions

3 Our primary conclusions are set out below.

Empirical and theoretical evidence of bias in SL-CAPM return estimates

4 Over several decades, the empirical finance literature has consistently reported that the relationship between beta and observed returns has a higher intercept and a flatter slope than the SL-CAPM suggests. Thus, 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. This empirical evidence is known by Australian regulators as 'low-beta bias.'

5 Black (1972) has developed a theoretical model that produces output that is more consistent with the empirical evidence than the SL-CAPM. The 'Black CAPM' replaces one of the strong assumptions of the SL-CAPM and it produces a

relationship between beta and returns that has a higher intercept and a flatter slope – consistent with the empirical evidence.

6 Thus, there are two sides of the coin in relation to this evidence:

a. There is an *empirical* aspect of this body of evidence – the relationship between beta and observed returns has a higher intercept and a flatter slope than the SL-CAPM suggests; and

b. There is a *theoretical* aspect of this body of evidence – the Black CAPM demonstrates that a change to SL-CAPM assumptions produces a higher intercept and a flatter slope, consistent with the empirical evidence.

Observed returns

7 There are two potential explanations for the fact that observed returns on low-beta stocks are systematically higher than the SL-CAPM suggests:

a. The selected model does not perfectly describe the process by which the aggregate market determines required returns; or

b. The selected model *does* perfectly describe the process by which the aggregate market determines required returns, but the actual returns over the period that was examined happened to deviate from the return that investors required/expected due to random chance.

8 When assessing how these alternative explanations should be weighed, the relevant considerations include the following:

a. The empirical evidence of low-beta bias is the most consistent, compelling and well-accepted empirical evidence in the field of asset pricing. The contributors to this literature include two Nobel Prize winners and the studies documenting low-beta bias in many countries have been published in the very top finance journals over several decades, and the empirical evidence of low-beta bias is so well-accepted that it appears in the standard finance textbooks; and

b. The literature since the documentation of low-beta bias has not questioned whether or not the empirical evidence is a real reflection of the returns that investors require/expect. Rather, the literature has focused on identifying and modifying the components of the SL-CAPM that lead to it systematically understating the returns on low-beta stocks.

9 In our view, there is no reasonable basis for a regulator:

a. Placing 100% weight on the proposition that the SL-CAPM perfectly describes the process by which the aggregate market determines required returns, so that any empirical evidence to the contrary reflects a deficiency in the empirical evidence rather the model; and

b. Giving no weight at all to the possibility that low-beta bias is a real effect.

Ex ante expected returns

10 The literature demonstrates that the *ex ante* required returns produce the same result that has been documented for *ex post* observed returns – the relationship between beta and required returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

11 We have applied this methodology to Australian data and we also find the same result – the relationship between beta and *ex ante* expected returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

12 To be clear, we do not suggest that the expected returns evidence should replace the evidence from observed returns. We only note that the qualitative relationship is the same – a higher intercept and flatter slope. We consider that observed returns do reflect investors' required returns and that the evidence from observed returns should be used when considering low-beta bias – in the same way the AER uses those realised returns to estimate beta and MRP.

Developments in the relevant literature

13 Since the empirical evidence of low-beta was first identified, the relevant literature has:

a. Continued to confirm the existence of low-beta bias;

b. Accepted that evidence as a real effect on the basis that stock returns, on average, reflect investors' expected/required returns; and

c. Considered what it is about the SL-CAPM that causes it to produce estimates that are systematically different from the observed data.

Market practice

14 There is evidence that independent experts and market practitioners commonly use an intercept above the prevailing government bond yield.

The evidence is relevant and robust and should not be disregarded

15 We have been asked to provide a view on the binary qualitative question of whether the empirical evidence of low-beta bias and the theoretical evidence of the Black CAPM should have a real role in the process for estimating the required return on equity. In our view, there are compelling reasons to have real regard to that evidence if the goal is to produce the best possible estimate of the required return on equity.

1.3 Author of report

16 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.

17 I have been assisted in the preparation of this report by Dr Damien Cannavan and Dr Khoa Hoang at the University of Queensland.

18 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 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 Background and context

2.1 The evidence of low-beta bias

19 Soon after the publication of the SL-CAPM, researchers began testing whether 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. In particular, the actual returns on low-beta stocks systematically and materially exceed the SL-CAPM estimates; a result that is known as low-beta bias. The mechanistic implementation of the SL-CAPM does not fit the observed data.

20 The literature documenting low-beta bias has been performed by the very top echelon of finance researchers, including two Nobel prize winners. Low-beta bias has been consistently documented across a number of markets. It has been documented in the very top peer-reviewed finance journals and in standard finance textbooks.

21 There is currently no real debate in the academic field of financial economics about this empirical evidence from observed stock returns. The relationship between beta and returns has a higher intercept and a flatter slope than the SL-CAPM suggests.

22 The AER has acknowledged the existence of low-beta bias. For example, the AER's recent Draft Guideline Explanatory Statement states that:

> We acknowledge that ex-post return data can indicate that actual returns exceed expected returns for low beta stocks.[1]

23 Also, most of the experts in the AER's concurrent evidence sessions agreed with the proposition that:

> There is sound evidence that low-beta stocks have exhibited higher returns than the S-L CAPM predicts.[2]

24 The relevant evidence is depicted in Figure 1 below. Because that empirical evidence is already well-known and well-accepted in the regulatory setting, we summarise it in Appendix 1 to this report.

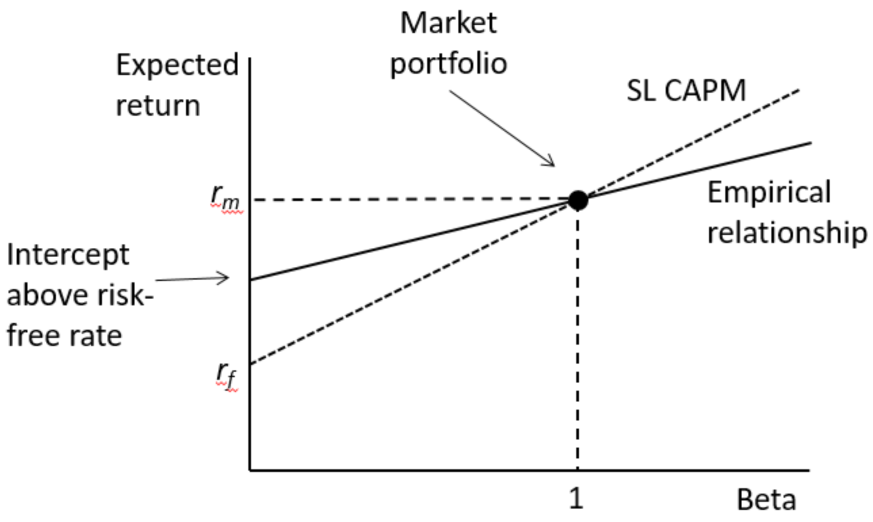
25 Over the years since low-beta bias was first documented, the finance literature has continued to confirm the existence of low-beta bias and has moved on to considering what it is about the SL-CAPM that causes it to systematically understate the returns on low-beta stocks. For example, Black (1972) 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 develops

[1] AER, July 2018, Draft Rate of Return Guideline, Explanatory Statement, p. 277.

[2] Joint Experts' Report, Proposition 5.21, p. 52. No experts disputed the existence of the empirical evidence, but instead stated that the size of the bias is difficult to reliably quantify.

a modified version of the CAPM that relaxes that assumption and the resulting 'Black CAPM' then provides a superior fit to the observed data. In other words, Black has developed a theoretical model that is consistent with the empirical evidence on low-beta bias.

Figure 1: Sharpe-Lintner CAPM vs. observed empirical relationship.



2.2 The AER's treatment of low-beta bias in the 2013 Guideline

26 The AER distinguishes between the theoretical Black CAPM evidence and the empirical evidence of low-beta bias:

a. There is an *empirical* aspect of this body of evidence – the relationship between beta and observed returns has a higher intercept and a flatter slope than the SL-CAPM suggests, such that the SL-CAPM systematically understates the observed returns on low-beta stocks; and

b. There is a *theoretical* aspect of this body of evidence – the Black CAPM, which was derived in response to the empirical evidence, demonstrates that a change to SL-CAPM assumptions produces a higher intercept and a flatter slope, consistent with the empirical evidence.

27 In its 2013 Guideline materials, the AER stated that its approach to equity beta was informed by the empirical as well as the theoretical evidence in this area:

> Theoretical and empirical evidence, however, supports using the Black CAPM, to some extent, in the process for estimating the return on equity. As such, we will use the Black CAPM to inform the selection of the equity beta.[3]

28 The 2013 Guideline materials also stated that the AER's approach to setting the equity beta would go some way towards mitigating the empirical evidence of low-beta bias:

> We consider that our implementation of the Sharpe–Lintner CAPM recognises the empirical criticisms of the model. For example, using the Black CAPM theory to inform our equity beta estimate may mitigate possible low beta bias. [4]

29 The AER considered that there was no sufficiently reliable estimate of the quantum of the bias, in which case it gave effect to that evidence by selecting a beta point estimate at the top of the range it had derived from its analysis of domestic comparators.[5]

2.3 The AER's 2018 Draft Guideline

30 The AER's 2018 Draft Explanatory Statement notes that the Black CAPM had a material role in the 2013 Guideline and in all subsequent AER decisions – it has been used (together with international evidence) as the basis for selecting a point estimate at the top end of the preliminary range derived from domestic comparators. For example:

> In the 2013 Guidelines and subsequent regulatory decisions, we used the theory of the Black CAPM (to account for potential market imperfections that may cause actual returns to diverge from expected returns) to select a point estimate towards the upper end of our empirical range.[6]

31 However, the 2018 Draft Guideline proposes that the theoretical evidence of the Black CAPM will now have no impact at all on the AER's allowed equity beta:

> …we do not consider it appropriate to use the (theory of the) Black CAPM when selecting our estimates [7]

and that the empirical evidence of low-beta bias will also have no effect.[8]

32 The key reason for giving no weight to the empirical evidence of low-beta bias is the distinction between the (*ex ante*) returns that investors expect/require and the

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[3] AER, December 2013, Rate of Return Guideline, Explanatory Statement, p. 58.

[4] AER, December 2013, Rate of Return Guideline, Explanatory Statement, Appendices, p. 12.

[5] AER, December 2013, Rate of Return Guideline, Explanatory Statement, Appendices, p. 275.

[6] AER, July 2018, Draft Rate of Return Guideline: Explanatory Statement, p. 275.

[7] AER, July 2018, Draft Rate of Return Guideline: Explanatory Statement, p. 284.

[8] AER, July 2018, Draft Rate of Return Guideline: Explanatory Statement, p. 277.

(*ex post*) returns that actually occur in the market.[9] The Explanatory Statement notes that the CCP raised this point:

> The CCP16 noted the low beta bias is based on ex-post empirical assessment of actual outturns which is not an unbiased estimate of ex-ante expectations.[10]

33 This point can be explained via a simple example. Suppose investors expect a particular asset to produce a payoff of $110 one year from now, and they consider that a 10% return would be appropriate. In this case, investors would price that asset at $100, expecting to receive their (*ex ante*) required return of 10%. Suppose that at the end of the year the actual payoff from the investment is $105. In this case, the (*ex post*) observed return is 5%. Thus, there is a difference between the *ex post* observed return and the *ex ante* required return.

34 The reason why the standard approach in empirical finance is to use observed returns as a proxy for expected/required returns is as follows. Over time, investors will continue to price assets on the basis of their required return. In some cases, the actual return will turn out to be higher than they expected/required and in some cases it will be lower – for a host of different reasons. But over a period of time, the average observed return will reflect the expected/required return that investors used when pricing the asset. That is, if investors price assets to generate an expected return of 10%, we would expect to observe a realised return of 10% on average over time. Thus, the average observed return over a period of time reflects the return that investors expect/require. Indeed, this is the whole basis for using observed market data for *any* parameter estimation purpose.

35 That is, there are two potential interpretations:

a. Low-beta stocks earn higher average returns than the SL-CAPM suggests because investors price them to earn a higher average return. That is, on average, the observed returns embody information about the returns that market investors require; or

b. Investors determine their expected/required return in accordance with the SL-CAPM, and the observed returns on low-beta stocks across multiple markets and time periods have been higher due to chance.

2.4 The role of this report

36 In this report, we note that the standard approach in empirical finance is based on the notion that investors are unlikely to generate systematically biased expectations, on average. Indeed, this 'rational expectations' framework is the basis of all asset pricing models, including the SL-CAPM. For example, if a particular stock consistently generated a return in excess of the market's expectation, it seems

[9] AER, July 2018, Draft Rate of Return Guideline, Explanatory Statement, p. 277.

[10] AER, July 2018, Draft Rate of Return Guideline, Explanatory Statement, p. 277.

unlikely that the market would maintain the same expectation and continue to be surprised year after year. In efficient capital markets, well-informed investors would exploit this mispricing, and the arbitrage opportunity would quickly be competed away. This is the basis for using observed returns (on average over a period of time) as a proxy for expected/required returns when estimating any cost of capital parameter.

37 However, given that the AER remains concerned about the possibility of a difference between *ex post* observed returns and *ex ante* expected/required returns, we consider approaches for estimating expected returns directly, rather than using observed returns as a proxy.

38 We show that the relationship between *expected* returns and beta estimates has a higher intercept and flatter slope than the SL-CAPM suggests (consistent with the empirical evidence from observed stock returns).

39 We also consider the conditions under which observed returns provide relevant information about required/expected returns. We demonstrate the widespread acceptance of the view that observed returns do indeed provide relevant information about required/expected returns.

3 Analysis of *expected* returns

3.1 Overview

40 We have noted above that the AER is concerned about the possibility of a difference between *ex post* observed returns and *ex ante* expected/required returns. In this section, we demonstrate that there are techniques for estimating *expected* returns directly. We review the evidence in relation to those techniques and we implement them using the Australian data. We show that the relationship between *expected* returns and beta estimates has a higher intercept and flatter slope than the SL-CAPM suggests (consistent with the empirical evidence from observed stock returns).

3.2 Direct estimation of expected returns

41 Section 2 above explains that the AER has expressed reluctance about relying on observed stock returns when assessing the evidence that the observed relationship between beta and returns has a higher intercept and a flatter slope than the SL-CAPM would suggest. The AER relies on the potential difference between *ex ante* required returns and *ex post* observed returns to justify disregarding this evidence.

42 Whether low-beta bias is also present in *expected* returns can be examined using direct estimates of *ex ante* expected returns rather than *ex post* observed returns as a proxy. The seminal paper in this area is Brav, Lehavey and Michaely (2005)[11] who replace observed *ex post* returns with *ex ante* expected/required returns in the empirical tests that have been developed in this area over some decades. Their estimate of expected/required returns is extracted from analyst estimates, as explained below. The use of implied returns extracted from analyst reports is motivated by the fact that there is a rich literature documenting the value-relevance of analyst forecasts. Section 4 below documents some of the research that shows how stock prices are sensitive to analyst forecast information.

43 Brav et al (2005) report that the *ex ante* expected returns produce the same result that has been documented for *ex post* observed returns – the relationship between beta and required returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

44 We have applied the Brav et al (2005) methodology to Australian data and we also find the same result – the relationship between beta and expected returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

[11] Brav, A., R. Lehavy, and R. Michaely, 2005. "Using expectations to test asset pricing models," *Financial Management*, Autumn, 31–64.

3.3 The Brav et al (2005) methodology

3.3.1 Approach

45 Brav, Lehavy and Michaely (2005), use Value-Line and First Call analyst forecasts to proxy expected/required returns. Their motivation for using these data sources to obtain estimates of *ex ante* expected/required returns is as follows:

> Although market expectations are unobservable, there are several reasons to believe that our measures of expected return represent a significant portion of the market's expectations. First, the Value Line and First Call estimates that we use impact market prices (Affleck-Graves and Mendenhall, 1992 and Womack, 1996). Second, researchers and practitioners have been using analysts' earnings and growth forecasts as a proxy for the market's estimates of these variables. Third, subscribers to both databases (which include individual investors, brokerage and asset management firms, and corporations) have been paying for these services (directly or indirectly) and it is likely that they would adopt these expectations (Ang and Peterson, 1985). Fourth, coverage is wide for both databases. Finally, Value Line expectations are unlikely to suffer from incentives-related biases. Therefore, we use these expectations in our main tests.[12]

46 Brav et al (2005) collect expected return data primarily from Value Line, an independent research provider that covers approximately 3,800 US stocks. They analyse results for the period 1975-2001. Their sample comprises 92% of the NYSE, AMEX, and Nasdaq in terms of market value. They also use First Call as an additional source of analysts' expectations to create a large sample of analysts' expected returns. These expected returns are obtained from sell-side analysts for more than 7,000 firms during the period 1997 through 2001.

47 Their general approach is to infer the expected return from analyst forecasts of future dividends and target prices. Effectively, the expected return is estimated by solving for r_e in the following equation:

$$P_0 = \sum_{i=1}^{N} \frac{d_i}{(1+r_e)^{t_i}} + \frac{TP}{(1+r_e)^{t_{TP}}}$$

where:

- P_0 represents the current observable stock price;
- TP represents the analyst forecast of the stock price at some future time t_{TP}; and
- d_i represents the analyst forecast of the dividend to be paid at time t_i.

3.3.1 Key findings

48 Brav et al (2005) report that the same result that has been documented for observed *ex post* returns also holds with *ex ante* expected returns – the relationship

[12] Brav et al (2005), p. 32.

between beta and expected returns has a higher intercept and a flatter slope than the SL-CAPM would suggest. Indeed, Brav et al report that the result is even more pronounced with expected returns – the intercept is even higher than is the case with observed stock returns.

3.4 Analysis of *ex ante* returns in Australia

3.4.1 Data source and methodology

49 Since Value Line data are not available for Australia, we use the I/B/E/S analyst forecast database, which is comparable to the First Call data used by Brav et al (2005). Our sample covers the period March 2002 to August 2017. All the data are collected via Thomson Reuters Datastream.

50 Analyst coverage increases significantly over this period, with 100 sample firms in March 2002 and 316 firms in August 2017. In total we have 1,199 firms over our 15-year sample period.

51 We follow the Brav et al (2005) methodology in analysing the Australian data, with the details of our approach set out in Appendix 2 to this report. This effectively involves the following cross-sectional regression specification being applied each month over the sample period:

$$\left(\hat{r}_e - r_f\right)_t = \alpha + \delta\hat{\beta}_t + \epsilon_t$$

where:

- $\left(\hat{r}_e - r_f\right)_t$ represents the analysts' expected excess return estimated at time t; and
- $\hat{\beta}_t$ represents the estimate of the firm's beta at time t.

52 Under the SL-CAPM, the regression intercept (α) would be zero and the slope coefficient (δ) would be equal to the market risk premium.

3.4.2 Results

53 Table 1 below documents the results from the regression described above performed on both an individual firm basis and a portfolio basis. These are estimates of expected excess returns and do not involve any realised returns. We have followed Brav et al (2005) in analysing and reporting *excess* returns – in excess of the prevailing risk-free rate. Thus, in these regressions, the SL-CAPM posits an intercept of zero and a slope equal to the market risk premium.

Table 1: Results for Australian sample compared with the results of Brav et al. (2005) and with values adopted by the AER

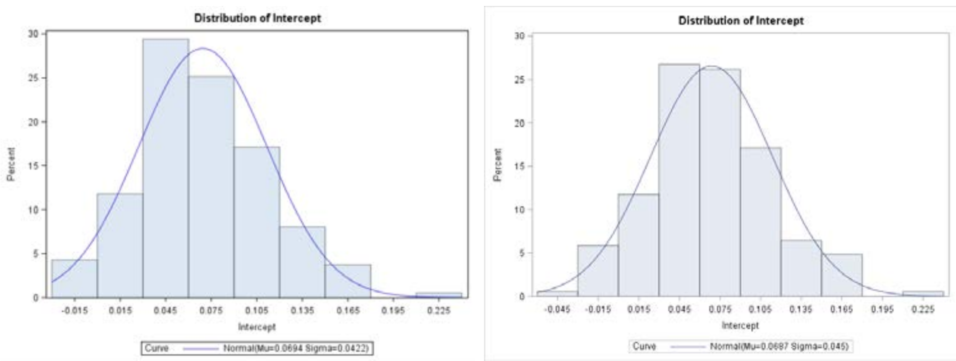
	AER	Brav – Value Line	Brav – First Call	Individual Firm Level	Portfolio Level Decile	Portfolio Level Quintile
		US data		Australian data		
Intercept	0	0.07	0.20	0.07	0.07	0.07
(*t*-statistic)		(3.2)	(5.8)	(12.66)	(11.76)	(11.47)
Slope	0.06	0.07	0.07	0.01	0.01	0.01
(*t*-statistic)		(5.1)	(4.3)	(2.08)	(1.91)	(2.40)

Source: AER, Brav et al (2005), Datastream, Frontier Economics calculations. AER allowances taken from 2018 Draft Guideline.

54 Table 1 demonstrates that the intercept terms are positive and statistically significant (at more than the 1% level) in all cases. That is, the relationship between the expected return and beta estimates has a higher intercept than the SL-CAPM suggests.

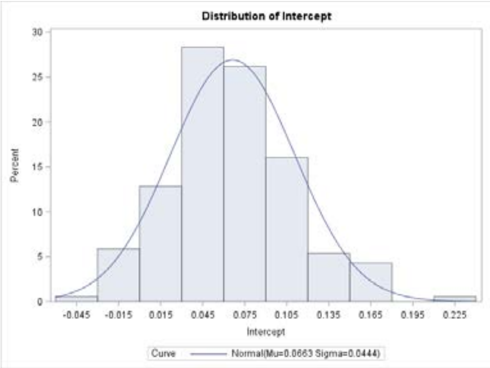
55 To ensure that the results are not driven by outliers, we examine the distribution of intercepts over time (an intercept is produced for the cross-sectional regression that is produced each month). The distributions of intercept terms for the various individual and portfolio specifications are set out in Figure 2 below. The intercept is consistently positive for almost every firm-year analysis, and the mean intercept is highly statistically significant.

Figure 2: Distribution of intercepts for individual firm-level time-series regressions for Australian data



Firm-level alphas

Portfolio alphas (deciles)



Portfolio alphas (quintiles)

Source: Frontier Economics calculations. These figures show the distribution of intercept estimates for each implementation of the regression in Paragraph 51 above. The bars represent the empirical distribution and the curve represents a normal distribution with mean and variance set equal to the empirical estimates from the distribution of intercepts. The figure shows that, in almost every case, the intercept is positive such that the expected return on low-beta stocks is higher than the SL-CAPM suggests.

3.4.3 Summary and conclusions from the Australian analysis

56 Testing of Australian data using the methodology employed by Brav et al. (2005) reveals a consistent and statistically significant intercept term. This is consistent with the empirical evidence from observed returns. Both sets of evidence are inconsistent with the SL-CAPM.

57 In particular, we find that the intercept in the relationship between beta and *expected* stock returns is higher than the SL-CAPM would suggest. Thus, the expected return on low-beta stocks is higher than the SL-CAPM estimates.

58 These findings are consistent with the well-documented empirical evidence in relation to observed stock returns (see Section 8 for a survey of this evidence in the academic literature). They are also consistent with the US results for expected stock returns provided by the earlier study of Brav et al (2005).

4 The development of the relevant academic literature

4.1 Overview

59 This section of the report documents that, since the empirical evidence of low-beta bias was first identified, the relevant literature has:

a. Continued to confirm the existence of low-beta bias;

b. Accepted that evidence as a real effect on the basis that stock returns, on average, reflect investors' expected/required returns; and

c. Considered what it is about the SL-CAPM that causes it to produce estimates that are systematically different from the observed data.

4.2 Black (1972)

60 Black (1972) summarises some of the relevant 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).[13]

61 In trying to develop a conceptual rationale for this 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

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

> obtained by Pratt, Friend and Blume, Miller and Scholes, and Black, Jensen and Scholes.[14]

62 That is, Black (1972):

a. Notes that there is consistent evidence about the empirical failings of the SL-CAPM – the empirical evidence suggests that the relationship between beta and returns has a higher intercept and a flatter slope than the SL-CAPM would suggest; and

b. Considers what it is about the SL-CAPM that causes it to produce estimates that are systematically different from the observed data. Black (1972) concludes that a driving problem is the SL-CAPM assumption that all investors can borrow and lend unlimited amounts at the same risk-free rate.

4.3 Fama and French (1996)

63 More recent papers continue to document the existence of low-beta bias and to develop models that better fit the observed stock returns. The literature accepts that the empirical evidence is a real reflection of the returns that investors require/expect. It then notes that this evidence presents a problem for the SL-CAPM.

64 For example, Fama and French (1996) examine the relationship between beta and observed stock returns in extensive empirical tests spanning decades. They document that the data is unable to reject the null hypothesis that beta is unrelated to stock returns.[15] They go on to document other problems with the SL-CAPM and conclude that:

> In our view, the evidence that β does not suffice to explain expected return is compelling. The average return anomalies of the CAPM are serious enough to infer that the model is not a useful approximation.[16]

4.4 Frazzini and Pederson (2014)

65 The more recent literature has focused on identifying and correcting the aspects of the SL-CAPM that causes it to systematically understate the returns on low-beta stocks.

66 For example, Frazzini and Pederson (2014) also note the body of evidence:

> Indeed, the security market line for U.S. stocks is too flat relative to the CAPM (Black, Jensen, and Scholes, 1972) and is better explained by the CAPM with restricted

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

[15] Fama and French (1996), Table 1, Panel B, p. 1951.

[16] Fama and French (1996), p. 1957.

> borrowing than the standard CAPM (Black, 1972, 1993, Brennan, 1971). See Mehrling (2005) for an excellent historical perspective.[17]

67 They then focus on the real-world leverage restrictions that investors face that impinge on the theoretical premise of the SL-CAPM – that all agents invest in the portfolio with the highest expected excess return per unit of risk and leverage or de-leverage this portfolio to suit their risk preferences. They rule out the possibility that the empirical relationship is caused by the market pricing idiosyncratic risk, preferring the 'constrained borrowing' explanation:

> Our results shed new light on the relation between risk and expected returns. This central issue in financial economics has naturally received much attention. The standard CAPM beta cannot explain the cross section of unconditional stock returns (Fama and French, 1992) or conditional stock returns (Lewellen and Nagel, 2006). Stocks with high beta have been found to deliver low risk-adjusted returns (Black et al., 1972, Baker et al., 2011); thus, the constrained-borrowing CAPM has a better fit (Gibbons, 1982, Kandel, 1984, Shanken, 1985). Stocks with high idiosyncratic volatility have realized low returns (Falkenstein, 1994, Ang et al., 2006, Ang et al., 2009), but we find that the beta effect holds even when controlling for idiosyncratic risk.

4.5 Liu, Stambaugh and Yuan (2018)

68 Liu, Stambaugh and Yuan (2018) also start by noting the large and well-accepted body of evidence:

> The beta anomaly [low-beta bias] is perhaps the longest-standing empirical challenge to the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) and asset-pricing models that followed. Beginning with the studies of Black et al. (1972) and Fama and MacBeth (1973), the evidence shows that high-beta stocks earn too little compared to low-beta stocks. In other words, stocks with high (low) betas have negative (positive) alphas [intercepts]. [18]

69 They then examine the possible cause of mispricing under the SL-CAPM, with a focus on omitted factors.

4.6 Hong and Sraer (2016)

70 The recent literature has also extended to the development of new equilibrium asset pricing models that relax certain restrictive assumptions of the SL-CAPM and derive an equilibrium that is more consistent with the observed data. For example, Hong and Sraer (2016) also begin by confirming the large body of empirical evidence:

> There is compelling evidence that high-risk assets often deliver lower expected returns than low-risk assets. This is contrary to the risk-return trade-off at the heart of neoclassical asset pricing theory. The high-risk, low-return puzzle literature, which

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[17] Frazzini and Pederson (2014), "Betting against beta," *Journal of Financial Economics* 111, 1-25, p.2.

[18] Liu, Stambaugh and Yuan, 2018, "Absolving beta of volatility's effects," *Journal of Financial Economics*, 128, 1-15 at p. 1.

> dates back to Black (1972) and Black, Jensen, and Scholes (1972), shows that low-risk stocks, as measured by a stock's comovement with the stock market or Sharpe's (1964) capital asset pricing model (CAPM) beta, have significantly outperformed high-risk stocks over the last 30 years. Baker, Bradley, and Wurgler (2011) further show that since January 1968 the cumulative performance of stocks has actually been declining with beta.[19]

71 Their focus is on relaxing two unrealistic assumptions that underpin the SL-CAPM. First, rather than assuming, as the SL-CAPM does, that investors face no constraints to trading, they assume some investors face short-sale constraints. Second, rather than assuming, as the SL-CAPM does, that investors all have the same beliefs, they assume that investors hold differing beliefs. They conclude that it may be these SL-CAPM assumptions that cause it to systematically understate the returns on low-beta stocks.

72 The AER briefly considers Hong and Sraer (2016) in its 2018 Draft Guideline Explanatory Statement.[20] The AER appears to recognise that the Hong and Sraer model is an equilibrium asset pricing model that does produce outcomes that are more consistent with the observed data – it is empirically superior to the SL-CAPM.

73 The AER's Explanatory Statement then focuses on the question of whether the Hong and Sraer model should replace the SL-CAPM as the AER's 'foundation model.' The AER concludes that the Hong and Sraer model should not be used as the foundation model because there is no evidence of it being used by market practitioners and because the AER has some concerns about the econometric analysis.

74 Both of these issues are debatable,[21] but are beside the point. The key point is that the Hong and Sraer model has not been proposed as an alternative to the SL-CAPM. Rather, it is cited as an example of an equilibrium model that *is* consistent with the observed data in a way that the SL-CAPM is not. It is a clear example of how the literature has moved on since the SL-CAPM was developed in the 1960s. It shows that the evidence of low-beta bias is accepted as a given fact and researchers are no longer questioning whether or not it is real, but are seeking to determine what it is about the SL-CAPM that causes it to systematically understate the returns on low-beta stocks and to correct those deficiencies.

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[19] Hong, H. and D. Sraer, 2016, "Speculative Betas," *Journal of Finance*, 71(5), 2095-2144, p. 2095.

[20] AER, July 2018, Draft Rate of Return Guideline, pp. 286-287.

[21] For example, whereas there is no evidence of practitioners citing Hong and Sraer (2016) specifically, there is extensive evidence of practitioners using an intercept above that of the SL-CAPM, as set out in Section 5 below. Certainly, there is very little evidence of practitioners implementing the SL-CAPM in the way the AER implements it. In relation to the econometric analysis, we note that the AER cites that Hong and Sraer remove very small and very low-priced stocks from their data set. This is a common practice in the relevant literature. The AER does not explain *why* it is concerned about the use of this standard practice. We note that the paper has gone through the peer review process and been published in the world's leading finance journal.

The development of the relevant academic literature

4.7 Asness et al (2018)

75 In an even more recent paper, Asness, Frazzini, Gormsen and Pedersen (2018) also begin by confirming the systematic empirical evidence:

> One of the major stylized facts on the risk-return relation, indeed in empirical asset pricing more broadly, is the observation that assets with low risk have high alpha [intercept], the so-called "low-risk effect" (Black, Jensen, and Scholes, 1972).
>
> Hence, the systematic low-risk effect is based on a rigorous economic theory and has survived more than 40 years of out of sample evidence.[22]

76 They focus on identifying which limitations of the SL-CAPM are responsible for the effect. For instance, whether the constraints on leverage, which exist in the real world but not in the SL-CAPM, are driving the effect or whether it is idiosyncratic risk (again ignored in the SL-CAPM) driving the effect.

77 We note that this issue is of more than mere academic interest. Asness and Pedersen are principals of AQR Capital Management that are responsible for investing more than $200 billion of investors' funds.

4.8 Australian evidence

78 SFG (2013)[23] evaluate Australian data and document a higher intercept and flatter slope than the SL-CAPM suggests. Specifically, the intercept in the relationship between beta and returns is shown to be approximately 3% above the SL-CAPM intercept.

79 Truong and Partington (2007)[24] also evaluate the CAPM, and variations of the dividend growth model, using Australian data. They conduct a range of analyses whereby actual returns are compared with the SL-CAPM estimate.[25] In every analysis the intercept is significantly positive and the slope is flatter than the SL-CAPM suggests. They also begin by noting the consensus that has developed in the literature:

> Although the CAPM emerges as the most popular model among practitioners, empirical tests show evidence of its disappointing performance. The cost of capital estimated using the CAPM does a poor job in explaining the variation of future stock returns (Fama and French, 1992, 1993).[26]

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22 Asness, Frazzini, Gormsen and Pedersen 2018, "Betting Against Correlation: Testing Theories of the Low-Risk Effect" CEPR Discussion Paper No. DP12686, p. 2.

23 SFG, 2013, Beta and the Black Capital Asset Pricing Model, 13 February.

24 Truong, G. and G. Partington, 2007, Alternative estimates of the cost of equity capital for Australian firms, University of Sydney.

25 Truong and Partington (2007), Tables 4 and 5, pp. 43-45.

26 Truong and Partington (2007), p. 2.

80 They go on to note that their results show that the SL-CAPM performs particularly poorly when assessed against the Australian data:

> The estimates from the CAPM are negatively correlated with one year ahead returns but demonstrate no significant association with two and three year ahead returns as shown in Panels A and B of Table 4. This finding is consistent with evidence of the poor performance of the CAPM generally found in previous empirical examinations of the model.[27]

81 They conclude that the vanilla SL-CAPM has no useful role in producing cost of capital estimates that have any relationship to actual stock returns, and that the DGM approach is superior:

> However, in this study, as in previous studies, the CAPM produces cost of capital estimates that have little ability to explain cross-sectional variations in future stock returns. There is a growing literature on the use of valuation models to estimate the implied cost of capital. This study using data from the Australian market contributes further empirical evidence to the literature in this area. Using both the CAPM and four valuation models, the cost of capital for a sample of Australian firms is estimated for the period from 1995 to 2004. Estimates from the models are evaluated based on their ability to explain the variation of future stock returns and their association with firm characteristics. The CAPM fails dismally in regard to the same criterion.[28]

4.9 Summary of developments in the academic literature

82 The key points made in this section of the report are that:

a. The empirical evidence of low-beta bias has been confirmed consistently over a number of decades. The literature continues to show that the relationship between beta and observed returns has a higher intercept and a flatter slope than the SL-CAPM suggests.

b. The literature considers the effect to be real and has moved on to identifying what it is about the SL-CAPM, and the assumptions that underpin it, that leads to it systematically understating the returns on low-beta stocks.

c. The issue is of real interest to leading investment managers.

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[27] Truong and Partington (2007), p. 25.

[28] Truong and Partington (2007), p. 33.

5 Evidence of market practice

5.1 Overview

83 We have noted above that there is consistent empirical evidence that the relationship between beta and observed returns has a higher intercept and a flatter slope than the SL-CAPM suggests. One question that then arises is whether market practitioners, when estimating required returns, adopt a higher intercept (and therefore a flatter slope) to be consistent with the observed evidence. The SL-CAPM sets the intercept equal to the prevailing risk-free rate, which is usually estimated as the yield on government bonds.

84 Thus, the question is whether there is evidence of market practitioners implementing the CAPM using an intercept above the prevailing government bond yield. In this section, we demonstrate that there is evidence that independent experts and market practitioners commonly use an intercept above the prevailing government bond yield.

5.2 Independent experts

85 In its recent Draft Guideline Explanatory Statement, the AER has noted the evidence that it is common for independent expert valuation reports to adopt an intercept above the prevailing government bond yield – consistent with the empirical evidence.[29]

86 For example, a recent KPMG report explains that:

> The risk free rate of return is the return on a risk free security, typically for a long-term period. In practice, long dated Government bonds are accepted as a benchmark for a risk free security. In Australia, the 10 year Commonwealth Government bond yield is commonly referenced, of which the spot yield was 2.63% as at 30 June 2018.
>
> However, since the global financial crisis in 2008, Government bond yields have remained low compared to long-term averages. Combined with market evidence which indicates that bond yields and the market risk premium are strongly inversely correlated, it is important that any assessment of the risk free rate should be made with respect to the position adopted in deriving the market risk premium. In this regard, KPMG Corporate Finance has adopted a long-term historical market risk premium as a proxy for the expected market risk premium and applied a higher risk free rate than the spot yield of the 10 year Commonwealth Government bond yield.
>
> We have adopted 3.9% as an appropriate risk free rate, which represents a blend of the spot rate and a forecast long-term bond yield of 4.15%.[30]

87 As another example, a recent Grant Thornton report explains that:

[29] AER, July 2018, Draft rate of return Guidelines: Explanatory Statement, pp. 206-207.

[30] KPMG, Independent Expert Report for Oroton Group Ltd, 5 July 2018, p.84.

> We note that the current spot yield is approximately 2.9%. However, given that the US Federal Reserve has raised the cash rates five times in the last 18 months, including on 14 June 2018 to between 1.75% to 2.00% and has signalled further increases over the next two years we have assessed a long-term risk free rate of c.3.5%. This is also consistent with forward rates and future yield curve.[31]

88 The KPMG 2017 Valuation Practice survey reports that 82% of respondents 'always' or 'often' apply an intercept above the prevailing risk-free rate.[32]

5.3 Survey respondents

89 The most recent surveys cited in the AER's Draft Guideline are those of Fernandez (2017, 2018) and KPMG (2017). In all cases, the relevant practitioners report using an intercept above the prevailing government bond yield – consistent with the empirical evidence.

90 For example:

a. Fernandez (2017, p. 4) reports that the median respondent adopts an intercept of 3.1% at a time when the prevailing 10-year government bond yield was 2.6%.

b. Fernandez (2018, p. 4) reports that the median respondent adopts an intercept of 3.0% at a time when the prevailing 10-year government bond yield was 2.7%.

c. KPMG (2017, p. 10) reports that the median respondent adopts an intercept in the range of 3.0% to 3.5% at a time when the prevailing 10-year government bond yield was 2.6%.

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31 Grant Thornton, Independent Expert Report for Sino Gas & Energy Holdings Ltd, 26 July 2018, p.75.

32 KPMG, 2017, KPMG valuation practices survey, p. 13.

6 Conclusions

Observed returns

91 There are two potential explanations for the fact that observed returns on low-beta stocks are systematically higher than the SL-CAPM suggests:

a. The selected model does not perfectly describe the process by which the aggregate market determines required returns; or

b. The selected model *does* perfectly describe the process by which the aggregate market determines required returns, but the actual returns over the period that was examined happened to deviate from the return that investors required/expected due to random chance.

92 When assessing how these alternative explanations should be weighed, the relevant considerations include:

a. The empirical evidence of low-beta bias is the most consistent, compelling and well-accepted empirical evidence in the field of asset pricing. The contributors to this literature include two Nobel Prize winners and the studies documenting low-beta bias have been published in the very top finance journals over several decades, and the empirical evidence of low-beta bias is so well-accepted that it appears in the standard finance textbooks; and

b. The literature since the documentation of low-beta bias has not questioned whether or not the empirical evidence is a real reflection of the returns that investors require/expect. Rather, the literature has focused on identifying and modifying the components of the SL-CAPM that lead to it systematically understating the returns on low-beta stocks.

93 In our view, there is no reasonable basis for regulators:

a. Placing 100% weight on the proposition that the SL-CAPM perfectly describes the process by which the aggregate market determines required returns, so that any empirical evidence to the contrary reflects a deficiency in the empirical evidence rather the model; and

b. Giving no weight at all to the possibility that low-beta bias is a real effect.

Ex ante expected returns

94 The AER has expressed reservations about making any adjustments to its estimate of the return on equity for low-beta bias on the grounds that much of the evidence for this phenomenon makes use of realised returns rather than expected returns. In response to this concern, we note that credible, published literature demonstrates that *ex ante* required returns produce the same result that has been

documented for *ex post* observed returns – the relationship between beta and required returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

95 We have applied this methodology to Australian data and we also find the same result – the relationship between beta and *ex ante* expected returns has a higher intercept and a flatter slope than the SL-CAPM would suggest.

96 To be clear, we do not suggest that the expected returns evidence should replace the evidence from observed returns. We only note that the qualitative relationship is the same – a higher intercept and flatter slope. We consider that observed returns do reflect investors' required returns and that the evidence from observed returns should be used when considering low-beta bias – in the same way those returns are used to estimate beta and MRP.

97 Therefore, in our view, the AER's grounds for making no adjustment for low-beta bias are unsound and unreasonable—given the overwhelming evidence that this bias is real and affects SL-CAPM estimates of the require return on equity of precisely the sorts of firms that the AER is responsible for regulating.

Developments in the relevant literature

98 Since the empirical evidence of low-beta was first identified, the relevant literature has:

a. Continued to confirm the existence of low-beta bias;

b. Accepted that evidence as a real effect on the basis that stock returns, on average, reflect investors' expected/required returns; and

c. Considered what it is about the SL-CAPM that causes it to produce estimates that are systematically different from the observed data.

Market practice

99 There is evidence that independent experts and market practitioners commonly use an intercept above the prevailing government bond yield.

The evidence is relevant and robust and should not be disregarded

100 We have been asked to provide a view on the binary qualitative question of whether the empirical evidence of low-beta bias and the theoretical evidence of the Black CAPM should have a real role in the process for estimating the required return on equity. In our view, there are compelling reasons to have real regard to that evidence if the goal is to produce the best possible estimate of the required return on equity.

Conclusions

7 References

Asness, C. S., Frazzini, A., Gormsen, N. J., Pedersen, L. H. "Betting against correlation: Testing theories of the low-risk effect." *CEPR Discussion Paper No. DP12686* (2018).

Asquith, P., Mikhail, M. B., Au, A. S. "Information content of equity analyst reports." *Journal of Financial Economics* 75 (2005), 245-282.

Barber, B., Lehavy, R., McNichols, M., Trueman, B. "Can Investors Profit from the Prophets? Security Analyst Recommendations and Stock Returns." *The Journal of Finance* 56 (2001), 531-563.

Berk, J., DeMarzo, P. *Corporate Finance*: Pearson (2014).

Black, F. "Capital Market Equilibrium with Restricted Borrowing." *Journal of Business* 45 (1972), 444-455.

Black, F., Jensen, M. C., Scholes, M. "The Capital Asset Pricing Model: Some Empirical Tests." (1972).

Bradley, D., Clarke, J., Lee, S., Ornthanalai, C. "Are analysts' recommendations informative? Intraday evidence on the impact of time stamp delays." *The Journal of Finance* 69 (2014), 645-673.

Brav, A., Lehavy, R. "An Empirical Analysis of Analysts' Target Prices: Short-term Informativeness and Long-term Dynamics." *The Journal of Finance* 58 (2003), 1933-1967.

Brav, A., Lehavy, R., Michaely, R. "Using expectations to test asset pricing models." *Financial management* 34 (2005), 31-64.

Brealey, R. A., Myers, S. C., Allen, F. *Principles of Corporate Finance*: McGraw-Hill/Irwin (2011).

Das, S., Guo, R.-j., Zhang, H. "Analysts' Selective Coverage and Subsequent Performance of Newly Public Firms." *The Journal of Finance* 61 (2006), 1159-1185.

Derrien, F., Kecskés, A. "The real effects of financial shocks: Evidence from exogenous changes in analyst coverage." *The Journal of Finance* 68 (2013), 1407-1440.

Fama, E. F., French, K. R. "Multifactor Explanations of Asset Pricing Anomalies." *The Journal of Finance* 51 (1996), 55-84.

Fama, E. F., French, K. R. "The capital asset pricing model: Theory and evidence." *Journal of Economic Perspectives* 18 (2004), 25-46.

Fama, E. F., MacBeth, J. D. "Risk, return, and equilibrium: Empirical tests." *Journal of Political Economy* 81 (1973), 607-636.

Frankel, R., Kothari, S. P., Weber, J. "Determinants of the informativeness of analyst research." *Journal of Accounting and Economics* 41 (2006), 29-54.

Frazzini, A., Pedersen, L. H. "Betting against beta." *Journal of Financial Economics* 111 (2014), 1-25.

Friend, I., Blume, M. "Measurement of portfolio performance under uncertainty." *The American Economic Review* 60 (1970), 561-575.

Grant Thornton, Independent Expert Report for Sino Gas & Energy Holdings Ltd, 26 July 2018, p.75.

Hilary, G., Hsu, C. "Analyst Forecast Consistency." *The Journal of Finance* 68 (2013), 271-297.

Hong, H., Sraer, D. A. "Speculative betas." *The Journal of Finance* 71 (2016), 2095-2144.

Kadan, O., Michaely, R., Moulton, P. C. "Trading in the presence of short-lived private information: Evidence from analyst recommendation changes." *Journal of Financial and Quantitative Analysis (Forthcoming)* (2017).

Kelly, B., Ljungqvist, A. "Testing Asymmetric-Information Asset Pricing Models." *The Review of Financial Studies* 25 (2012), 1366-1413.

KPMG, Independent Expert Report for Oroton Group Ltd, 5 July 2018, p.84.

KPMG, 2017, KPMG valuation practices survey.

Lee, C. M. C., So, E. C. "Uncovering expected returns: Information in analyst coverage proxies." *Journal of Financial Economics* 124 (2017), 331-348.

Liu, J., Stambaugh, R. F., Yuan, Y. "Absolving beta of volatility's effects." *Journal of Financial Economics* 128 (2018), 1-15.

Loh, R. K., Stulz, R. M. "When Are Analyst Recommendation Changes Influential?" *The Review of Financial Studies* (2011), 593-627.

Loh, R. K., Stulz, R. M. "Is Sell-Side Research More Valuable in Bad Times?" *The Journal of Finance* 73 (2018), 959-1013.

Merkley, K., Michael, R., Pacelli, J. "Does the Scope of the Sell-Side Analyst Industry Matter? An Examination of Bias, Accuracy, and Information Content of Analyst Reports." *The Journal of Finance* 72 (2017), 1285-1334.

Newey, W. K., West, K. D. "A simple, positive semi-definite, heteroskedasticity and autocorrelationconsistent covariance matrix." *Econometrica (1986-1998)* 55 (1987), 703.

Partington, G., Robinson, D., Brealey, R. A., Myers, S. C. *Principles of Corporate Finance*: McGraw Hill, Australia (2000).

Partington, G. and S. Satchell, 2017, Report to the AER: Discussion of submissions on the cost of equity, June.

Pratt, S. P., Grabowski, R. J. *Cost of capital: Applications and examples*: Wiley (2014).

SFG, 2013, Beta and the Black Capital Asset Pricing Model, 13 February.

So, E. C. "A new approach to predicting analyst forecast errors: Do investors overweight analyst forecasts?" *Journal of Financial Economics* 108 (2013), 615-640.

Truong, G. and G. Partington, 2007, Alternative estimates of the cost of equity capital for Australian firms, University of Sydney.

References

8 Appendix 1: The empirical evidence of low-beta bias

8.1 Overview

101 This section summarises some of the relevant body of evidence for the low-beta bias phenomenon that emerged in the years following the development of the SL-CAPM.

8.2 Black, Jensen and Scholes (1972)[33]

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

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

103 For example, Black, Jensen and Scholes (1972) construct tests of the model in the form of the following regression specification:[34]

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

104 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.[35]

105 The main result of Black, Jensen and Scholes (1972) is summarised in Figure 3 below. In that figure, the dashed line represents the security market line[36] that is implied by the SL-CAPM and the grey line represents the best fit to the empirical data. The data suggest that the intercept is too high and the slope is too flat to be consistent with the SL-CAPM.

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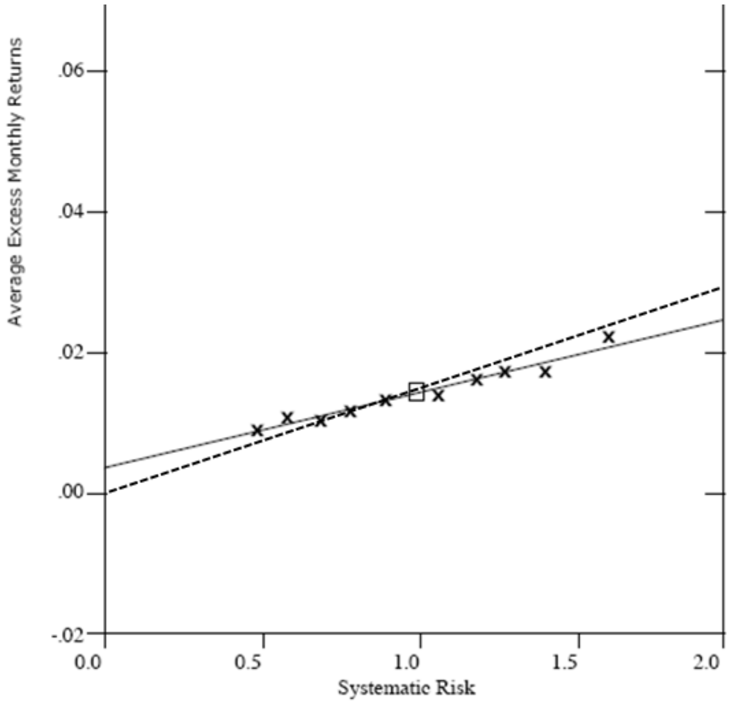
33 Black, F., M.C. Jensen, and M. Scholes, 1972, "The Capital Asset Pricing Model: Some empirical tests," in *Studies in the Theory of Capital Markets,* Michael C. Jensen, ed., New York: Praeger, 79–121.

34 See, for example, Black, Jensen and Scholes (1972), p. 3.

35 Black, Jensen and Scholes (1972), p. 4.

36 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 3: 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.

106 Black, Jensen and Scholes (1972) go on to define the intercept of the empirical regression line to be R_z. They report that the intercept over their sample period of 1931 to 1965 was approximately 4% above the theoretical SL-CAPM intercept.[37] 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.[38]

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.[39]

107 The empirical relationship and the implications of the SL-CAPM are contrasted in Figure 4, which shows the SL-CAPM in its usual form. (Note that in Figure 3

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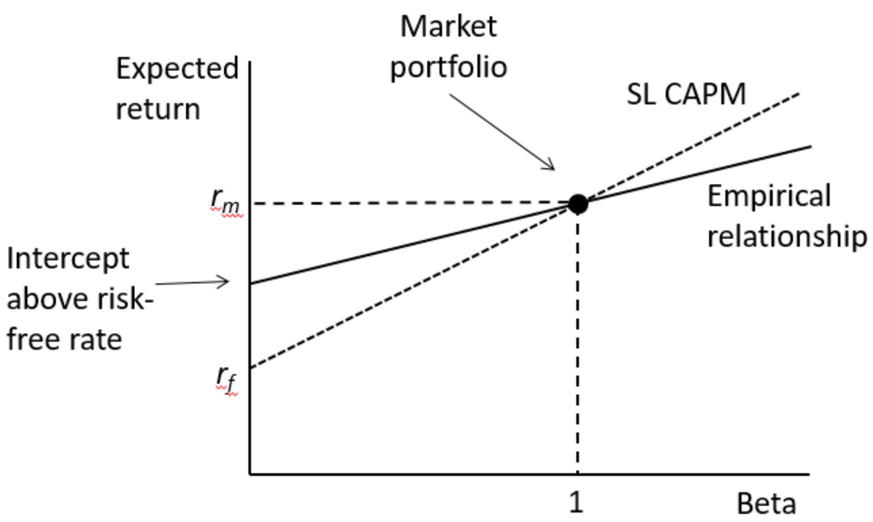
[37] Table 5, p. 38 reports a monthly zero beta premium of 0.338% per month, which is approximately equivalent to 4% per year.

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

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

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

Figure 4: Sharpe-Lintner CAPM vs. observed empirical relationship.



8.3 Friend and Blume (1970)[40]

108 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:[41]

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

109 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 5 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. [42]

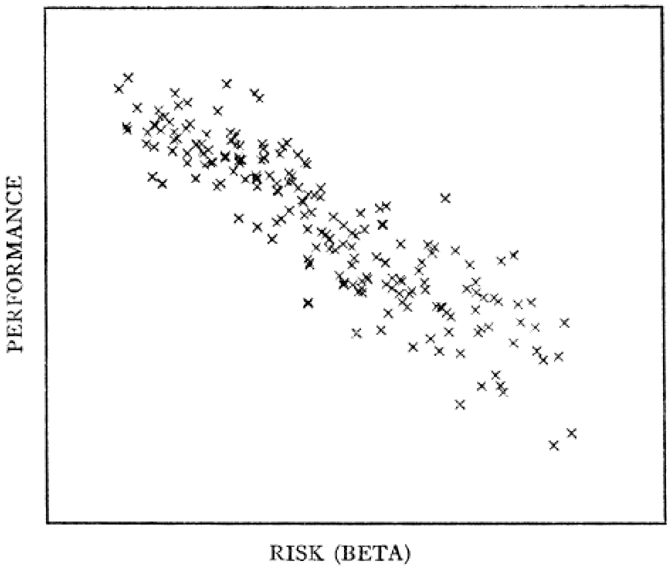
[40] Friend, I., and M. Blume, 1970, "Measurement of portfolio performance under uncertainty," *American Economic Review*, 60, 561–75.

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

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

Appendix 1: The empirical evidence of low-beta bias

Figure 5: The relationship between abnormal returns and beta



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

110 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.[43]

8.4 Fama and MacBeth (1973)[44]

111 Fama and MacBeth (1973) use the following regression specification:[45]

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

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

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

[45] See Fama and MacBeth (1973), p. 611.

112 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:

> 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}.[46]

113 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.[47]

8.5 Fama and French (2004)[48]

114 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."

115 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 6 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.

116 Again, the actual relationship between beta and returns has a higher intercept and a flatter slope than the SL-CAPM suggests.

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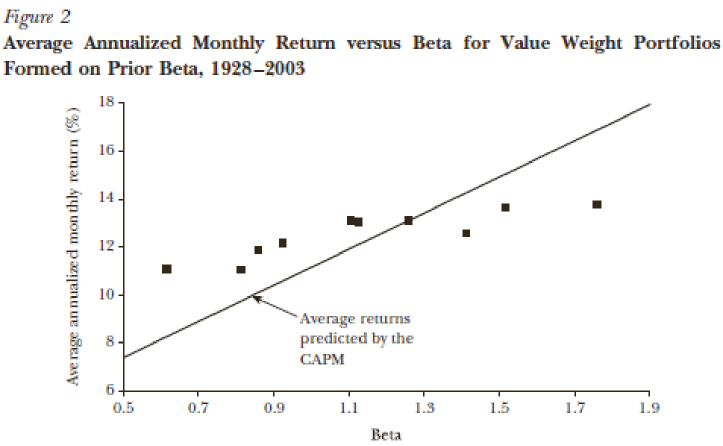
[46] Fama and MacBeth (1973), p. 630.

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

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

Figure 6. Average returns versus beta over an extended time period



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

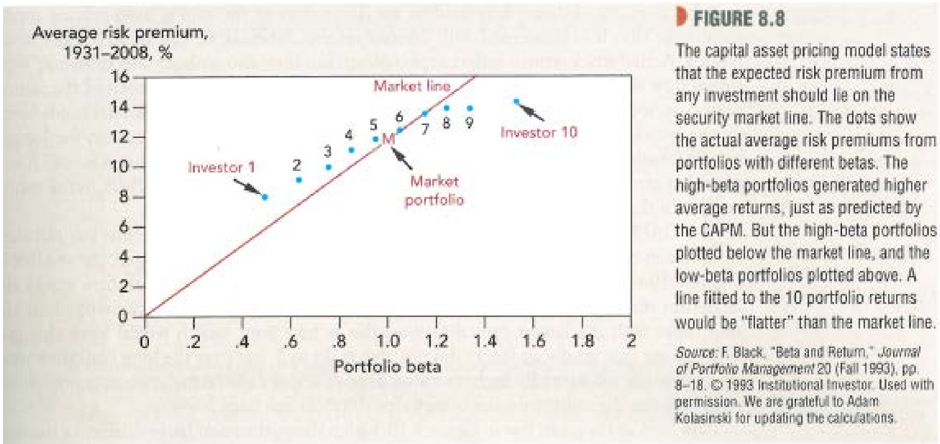
8.6 Brealey, Myers and Allen (2011)[49]

117 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 Figure 7 below. 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.

118 The pattern of a higher intercept and a flatter slope than the SL-CAPM suggests is again obvious.

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

Figure 7: The relationship between excess returns and beta



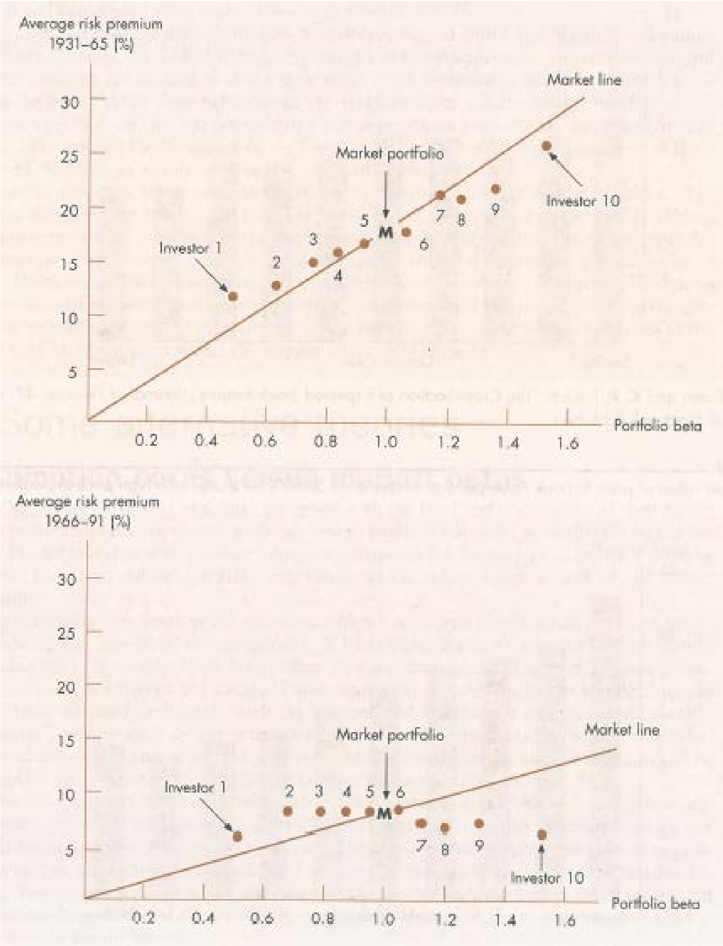
Source: Brealey, Myers, and Allen (2011), p. 197.

8.7 Partington et al (2000)[50]

119 Partington et al (2000) note that the evidence of low-beta bias has become more material in the more recent data, as summarised in Figure 8 below – the intercept has become even higher and the slope even flatter.

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

Figure 8: The relationship between excess returns and beta



Source: Partington, G., D. Robinson, R. Brealey and S. Myers, 2000, Principles of Corporate Finance: Australian Edition, p. 211.

8.8 Berk and DeMarzo (2014)[51]

120 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 note specifically 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:

$$E[R_i] = r^* + \beta_i \left(E[R_{Mkt}] - r^* \right)$$

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

That is, the SML holds with some rate r^* in place of r_f.[52]

8.9 Pratt and Grabowski (2014)[53]

121 Pratt and Grabowski (2014) is an applied valuation text that is commonly used by practitioners. Pratt and Grabowski note that concerns about the SL-CAPM have been raised by academics and practitioners:

> Despite its wide adoption, academics and practitioners alike have questioned the usefulness of CAPM in accurately estimating the cost of equity capital and the use of beta as a reliable measure of risk.[54]

122 They go on to note that one of the reasons for concern about the usefulness of the SL-CAPM is the empirical evidence of low-beta bias:

> The CAPM cost of equity estimates for high-beta stocks are too high, and estimates for low- beta stocks are too low, relative to historical returns.[55]

123 They conclude that the theoretical basis for the SL-CAPM:

> does not negate the results of empirical studies that show that beta alone is not a reliable measure of risk and realized future returns (at least not using betas drawn from realized excess returns).[56]

and they recommend the use of modified versions of the CAPM that produce estimates that are more consistent with the observed data – to correct for the empirical failings of the SL-CAPM.

8.10 Summary of the empirical evidence

124 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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[52] Berk and DeMarzo (2014), p. 399.

[53] Pratt, S. and R. Grabowski, 2014, *Cost of capital: Applications and examples,* 5th ed., Wiley.

[54] Pratt and Grabowski (2014), p. 269.

[55] Pratt and Grabowski (2014), p. 281.

[56] Pratt and Grabowski (2014), pp. 284-285.

Appendix 1: The empirical evidence of low-beta bias

9 Appendix 1: The Brav et al (2005) methodology for direct estimation of expected returns

9.1 Value Line data and methodology

Data source

125 Brav et al. (2005) construct estimates of expected returns using analysts' target prices. They source the majority of their data on target prices from Value Line (hereafter, VL). VL publishes weekly research reports for individual companies. It analyzes each company on a quarterly cycle such that a typical firm receives four reports per year.

126 Brav et al (2005) point out that since VL is an independent research service with no affiliation to any investment banking activity, the VL expected return is less likely to be affected by optimism bias or conflict of interest bias. Further, there are as many reports with negative recommendations as with positive, so there is no reason to suspect positive or negative bias. The VL estimates cover approximately 90% of US traded firms in terms of their market value.

Step-by-step guide to the analysis

127 The approach to estimating the relationship between beta and expected returns using the Value Line data is as follows:

- Step 1: Collect price target reports from the VL database for the period 1975 through 2001. This collection is restricted to firms with common shares (CRSP share codes 10 and 11)
- Step 2: Collect the market capitalisation of each sample firm, calculated at the end of the prior month.
- Step 3: Collect data on the annual common shareholders' equity (Compustat item #60) for each firm.
- Step 4: Calculate the book-to-market ratio for each firm as the ratio of annual common shareholders' equity to market capitalisation at the end of the fiscal year. Apply this ratio to the 12-month period beginning six months subsequent to the end of the fiscal year
- Step 5: Calculate price momentum for each firm for each month as the buy-and-hold return for the 11-month period ending one month prior to the relevant month.

- Step 6: Construct size decile portfolios – this is based on NYSE capitalization cut-offs.
- Step 7: Construct book-to-market ratio decile portfolios. This is based on the universe of available firms on CRSP (excluding those with non-common shares).
- Step 8: Construct momentum decile portfolios. This is based on the universe of available firms on CRSP (excluding those with non-common shares).
- Step 9: Report the decile portfolio statistics for the size, book-to-market and momentum characteristics respectively for both the universe and the VL population.
- Step 10: Take the average of the high and low range of expected prices from each VL report and divide by the firm's market price outstanding prior to the VL report date (convert all prices to the same split-adjusted basis).
- Step 11: For the sample period prior to 1987, for each firm in the sample calculate estimates of the annual dividend yield and growth rates of dividends immediately prior to the calculation of the expected return. Calculate dividends as the sum of the dividends paid in the fiscal year before the price target is issued (Compustat data item #21). Calculate dividend growth rate as the ratio of current to prior year dividend per share (as found in Compustat data item #26), adjusted for stock splits. Calculate the dividend yield as the estimated dividend for the next year relative to the end-of-year stock price.
- Step 12: Calculate the following expression for the expected return: (assumes that dividends will continue to grow at the same historical rate, g_H, in the following four years):

$$(1+ER_t^{VL})^4 = \frac{TP_t}{P_{t-9}} + \left(\frac{D}{P}\right)_H \cdot (1+g_H) \cdot \left[\frac{\left(1+ER^{VL}\right)^4-(1+g_H)^4}{ER^{VL}-g_H}\right] \quad (1)$$

  where $\frac{TP_t}{P_{t-9}}$ is the expected return without the dividends. Solve for the annualised expected return ER_t^{VL} that satisfies this equality.

- Step 13: For the period 1987 through 2001, obtain VL analysts' forecasts for both dividend growth rates and the next-year dividends. Use those estimates in calculating prospective dividend yield:

$$(1+ER_t^{VL})^4 = \frac{TP_t}{P_{t-9}} + \frac{Div_{next\ year} \cdot \left[\frac{(1+ER^{VL})^4-(1+g)^4}{ER^{VL}-g}\right]}{P_{t-9}} \quad (2)$$

  where g is the VL forecasted dividend growth rate, $Div_{next\ year}$ is the VL forecast of next year dividends. Solve for the annualized expected return ER_t^{VL} as in Equation (1) above.

- Step 14: Compute expected return for each firm for each quarter.

Appendix 1: The Brav et al (2005) methodology for direct estimation of expected returns

- Step 15: Calculate time series of the sample annual expected returns based on equal weighting of individual firm forecasts.
- Step 16: Calculate time series of the sample annual expected returns based on value weighting of individual firm forecasts. For each period, value-weight all firms' expected return by their prior period market value of equity.
- Step 17: For each firm on a monthly basis, calculate firm-specific factor loadings on size and book-to-market factors using the preceding 60 months. Minimum requirement is 24 months of valid data.
- Step 18: Use the VL firm-specific market beta provided in each report.
- Step 19: Construct a monthly time series of one-year expected excess returns - equal to the difference between the VL expected return estimate and the one-year risk free rate obtained from the Fama-Bliss files on CRSP.
- Step 20: Run month-by-month regressions of the one-year excess return on the estimated factor loadings.
- Step 21: Compute the time-series average of the intercept and slope coefficients.
- Step 22: Winsorize monthly observations at the 1st and 99th percentiles to mitigate the possible effect of extreme observations. The *t*-statistics adjusted for the overlapping nature of the data are the ratio of the time-series average divided by the estimated time-series standard error.

9.2 First Call data and methodology

Data source

128 In addition to the Value Line data, Brav et al (2005) also construct an expected return measure based on the First Call database (hereafter, FC), which gathers target prices issued by sell-side analysts. They use the FC one-year-ahead target price forecasts for over 7,000 firms during the period 1997 through 2001. By using these target price forecasts, they calculate analysts' annual expected returns for each stock. The information provided by FC is disseminated widely to all major institutional investors as well as many other investors, including individuals.

129 A key strength of the FC data is that there are forecasts from multiple analysts:

> Another advantage of this set of expectations is that a typical stock receives a target price from more than one analyst (on average, there is a target price from eight analysts per stock). As a result, the average (or the median) FC target price is likely to be less noisy and thus better reflect the consensus opinion.

130 Brav et al (2005) do note the potential concern with optimistic bias in analyst forecasts:

> On the other hand, a potential concern with sell-side analysts' expectations and recommendations is that they are biased (e.g., Rajan and Servaes, 1997, Michaely and Womack, 1999, and Barber, Lehavy, and Trueman, 2005) and that their forecasts may not accurately represent market expectations.

However, they note that this is attenuated by the fact that the same analysts are used to provide earnings forecasts and target prices. Thus, any bias would be expected to materially cancel out as it appears on both sides of the equation – in earnings forecasts and target prices.

131 Brav et al (2005) conclude that sell-side analysts' expectations are likely to be correlated with those of investors. They cite Vissing-Jorgensen (2003) who reports a similar time series pattern in individuals' expected market returns (using a UBS/Gallup monthly telephone survey of individual investors over the period 1998 through 2002).

132 The coverage of the FC data base increases over time from about 49,000 price target reports in 1997 to about 92,000 reports in 2001. The average number of price targets per covered firm also increases from 11 in 1997 to 23 in 2001. The target price database includes reports for 7,073 firms with, on average, eight brokerage houses covering each firm.

Step-by-step guide to the analysis

133 The approach to estimating the relationship between beta and expected returns using the FC data is as follows:

- Step 1: Collect price target reports from the FC database for the period 1997 through 2001. This collection is restricted to firms with common shares (CRSP share codes 10 and 11)
- Step 2: Collect the market capitalisation of each sample firm, calculated at the end of the prior month.
- Step 3: Collect data on the annual common shareholders' equity (Compustat item #60) for each firm.
- Step 4: Calculate the book-to-market ratio for each firm as the ratio of annual common shareholders' equity to market capitalisation at the end of the fiscal year. Apply this ratio to the 12-month period beginning six months subsequent to the end of the fiscal year
- Step 5: Calculate price momentum for each firm for each month as the buy-and-hold return for the 11-month period ending one month prior to the relevant month.
- Step 6: Construct size decile portfolios – this is based on NYSE capitalization cut-offs.

Appendix 1: The Brav et al (2005) methodology for direct estimation of expected returns

- Step 7: Construct book-to-market ratio decile portfolios. This is based on the universe of available firms on CRSP (excluding those with non-common shares).
- Step 8: Construct momentum decile portfolios. This is based on the universe of available firms on CRSP (excluding those with non-common shares).
- Step 9: Report the decile portfolio statistics for the size, book-to-market and momentum characteristics respectively for both the universe and the FC population.
- Step 10: Exclude individual target prices outstanding for more than 30 days. In any given month over the period 1997 through 2001 calculate the ratio of each individual analyst target price to the stock price outstanding two days prior to the announcement of the individual target price (Convert all prices to the same split-adjusted basis.) For any given month, average the individual analysts' expectations to obtain the consensus expected return.
- Step 11: For the sample period prior to 1987, for each firm in the sample calculate estimates of the annual dividend yield and growth rates of dividends immediately prior to the calculation of the expected return. Calculate dividends as the sum of the dividends paid in the fiscal year before the price target is issued (Compustat data item #21). Calculate dividend growth rate as the ratio of current to prior year dividend per share (as found in Compustat data item #26), adjusted for stock splits. Calculate the dividend yield as the estimated dividend for the next year relative to the end-of-year stock price.
- Step 12: Calculate the dividend yield as the estimated dividend next year relative to the price two days prior to the issuance date of the price target. The adjustment to the expected return is then the product of the dividend yield and (one plus) the growth rate, g, of dividends:

  $$1 + ER_t^{FC} = \frac{TP_t}{P_{t-2}} + \frac{Div_{current}(1+g)}{P_{t-2}} \quad (3)$$

  where TPt /Pt-2 is the stock's consensus expected return without the dividends.
- Step 13: Compute expected return for each firm for each month.
- Step 14: Calculate time series of the sample annual expected returns based on equal weighting of individual firm forecasts.
- Step 15: Calculate time series of the sample annual expected returns based on value weighting of individual firm forecasts. For each period, value-weight all firms' expected return by their prior period market value of equity.
- Step 16: For each firm on a monthly basis, calculate firm-specific factor loadings on size and book-to-market factors using the preceding 60 months. Minimum requirement is 24 months of valid data.

Appendix 1: The Brav et al (2005) methodology for direct estimation of expected returns

- Step 17: Do the same for the market beta factor.
- Step 18: Construct a monthly time series of one-year expected excess returns, equal to the difference between the expected return estimate and the one-year risk free rate obtained from the Fama-Bliss files on CRSP.
- Step 19: Run month-by-month regressions of the one-year excess return on the estimated factor loadings.
- Step 20: Compute the time-series average of the intercept and slope coefficients.
- Step 21: Winsorize monthly observations at the 1st and 99th percentiles to mitigate the possible effect of extreme observations. The t-statistics adjusted for the overlapping nature of the data are the ratio of the time-series average divided by the estimated time-series standard error.

9.3 Australian data and methodology

Data source

134 Since Value Line data is not available for Australia, we use the I/B/E/S analyst forecast database, which is comparable to the First Call data used by Brav et al (2005). Our sample covers the period March 2002 through to August 2017. All the data is collected via Thomson Reuters Datastream.

135 Analyst coverage increases significantly over this period, with 100 sample firms in March 2002 and 316 firms in August 2017. In total we have 1,199 firms over our 15-year sample period.

Step-by-step guide to the analysis

136 The approach to estimating the relationship between beta and expected returns using the Australian data is as follows:

- Step 1: Collect the 12-month price targets and median one-year-ahead dividend forecasts for all available firms in the IBES analyst forecast database.
- Step 2: For each firm in our sample, we collect end-of-month price and return data, adjusted for corporate events e.g. share bonuses, right offerings, stock splits and spin-off. We also collect market value for individual firms.
- Step 3: We collect the 10-year Australian Government Bond Yield to proxy for the risk-free rate from Thomson Reuters.
- Step 4: We use the Total Returns Index (including dividends) to calculate the market returns.
- Step 5: Unlike Brav et al. (2005), we do not have data on the staleness of target prices, so we are not in a position to exclude individual targe prices outstanding

for more than 30 days. We also use the consensus forecast to calculate our expected returns rather than taking the average of individual expected returns. Our main tests rely primarily on the median values to alleviate the optimism bias in analyst forecasts.

- Step 6: Instead of estimating a dividend growth rate using current and prior period dividends, we use the one-year ahead dividend forecast directly, because we wish to utilise market expectations as closely as possible. Again, our main tests utilize median values to reduce the potential optimism bias.

- Step 7: This allows us to estimate the one-year expected return by solving for the following:

$$1 + ER_t = \frac{TP_t + E_t(D_{t+1})}{P_t} \quad (4)$$

where ER_t is the expected return over the next 12 months, TP_t is the one-year target price, $E_t(D_{t+1})$ is the one-year ahead dividend forecast and P_t is the current share price.

- Step 8: Compute expected return for each firm for each month. To prevent the effect of outliers, we remove from our sample observations with an estimated cost of capital of greater 20% or less than 0%. Similarly. we restrict our analysis to the largest 100 firms by market capitalisation.

- Step 9: We use the market model to estimate individual firm beta for each month as below:

$$R_{i,t} = \alpha_i + \beta R_{m,t} + \varepsilon_{i,t} \quad (5)$$

where $R_{i,t}$ is the firm realised returns at time *t*, α_i is the intercept of the regression, β is the coefficient estimate, and $R_{m,t}$ is the market return at time *t*. In month t, we run the time series regression using 60-month data preceding that month to obtain the beta estimate i.e. We also require a minimum of 24 valid monthly returns.

- Step 10: After obtaining the expected return and beta estimates for each firm-month, we perform the individual Capital Asset Pricing Test (Individual CAPM) using the Fama-MacBeth (1973) method. Specifically, for each month, we run a cross-sectional regression of the ex-ante expected returns excess returns on the beta estimates:

$$ER_i - R_f = \alpha + \beta_i \gamma + \epsilon_i \quad (6)$$

where ER_i is the firm ex-ante expected returns, α_t is the intercept of the regression, γ is the coefficient estimate, and β_i is the firm i's systematic risk estimated from equation (2).

- Step 11: Calculate the time series averages of the cross-sectional regressions estimates α and γ. To judge the statistical significance of the estimates, we use the Newey-West (1987) t-statistics corrected for auto-correlation.
- If the CAPM fails to explain expected returns, we would expect the mispricing error i.e. intercept α is statistically different from 0. The coefficient γ can be interpreted as the market risk premium.
- Step 12: We test the CAPM on the portfolio level. We form ranked-beta decile portfolios. In particular, in December each year, we allocate firms into deciles based on their historical betas. For example, Decile 1 contains firms with the 10% lowest betas, while the top 10% highest beta firms are in Decile 10. We then calculate the portfolios' equal-weighted returns for the next 12 months. We reform the portfolios annually in December.
- Step 13: With the sample of portfolio returns, we estimate portfolio betas using equation (2). We use 24-month rolling regression to estimate the portfolio betas.
- Step 14: We repeat the CAPM test as in (3) on the portfolio level. We again use Newey-West (1987) *t*-statistic to correct for the autocorrelation.

Appendix 1: The Brav et al (2005) methodology for direct estimation of expected returns

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