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Estimates of the Cost of Equity

A report for WAGN

NERA

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Executive Summary

A critical determinant of the profitability of a gas distributor is the return on equity that the Economic Regulation Authority (ERA) allows the business. The return investors require on capital assets will largely be determined by the risk that investors face in holding the assets. There exist a large number of different pricing models that make an array of assumptions about the behaviour of investors and measure risk in a variety of ways. These models deliver a range of estimates of the return investors require on the capital gas distributors and transmitters invest. In this paper we examine a number of pricing models, the empirical evidence on whether they work and the estimates that they deliver of the return that equity investors require on the capital that gas distributors invest.

Historically, the ERA has chosen to use a version of perhaps the simplest pricing model, the Sharpe-Lintner Capital Asset Pricing Model (CAPM), to determine the rate of return on equity. The National Gas Rules, though, do not prescribe that this model be used to determine the return on capital. Instead, the rules state that:

> The rate of return [to a gas distributor or transmitter] is to be commensurate with prevailing market conditions in the market for funds and the risks involved in providing reference services.
>
> In determining a rate of return on capital a well accepted approach that incorporates the cost of equity and debt, such as the Weighted Average Cost of Capital, is to be used; and a well accepted financial model, such as the Capital Asset Pricing Model is to be used.

Thus the rules emphasise that the financial or pricing model must be well accepted but do not prescribe that a version of the Sharpe-Lintner CAPM be used.

Nevertheless, to begin with we examine the Sharpe-Lintner CAPM. The model, widely regarded as the first modern pricing theory, is perhaps the simplest pricing model. Although it has been known for many years that the model underestimates the returns to low-beta assets, its simplicity makes it a popular model among practitioners. We also examine a zero-beta version of the Sharpe-Lintner CAPM, the Black CAPM. The Black CAPM is an attractive model because it is a more general version of the Sharpe-Lintner CAPM. In the Black CAPM, zero-beta assets, that is, assets with no systematic risk, need not earn the risk-free rate. As a result, low-beta stocks, like utility businesses, are estimated to earn a higher return under the Black CAPM than under the Sharpe-Lintner CAPM.

The Sharpe-Lintner and Black models, although simple, are known to misprice value stocks and the stocks of firms with low market capitalisations. Fama and French introduce a three-factor model that, at the small cost of a little less simplicity, correctly prices these two classes of assets. We examine their model and also a zero-beta version of the model that more accurately estimates the returns to low-beta stocks.

We use these four pricing models and both domestic and international data to estimate the return the market requires on a portfolio of nine Australian energy utility stocks.[1] When we use only domestic data we are implicitly assuming that the Australian equity market is segmented from international equity markets. When we use international data we assume that the Australian equity market is at least partially integrated with international equity markets.

We find that estimates of the return the market requires on a portfolio of nine Australian energy utility stocks display some variation across the four models and two sets of data. In particular, we find, irrespective of whether we use domestic or international data, that the estimates are higher for the Black CAPM than for the Sharpe-Lintner CAPM, higher for the Fama-French three-factor model than for the Sharpe-Lintner CAPM and higher for the zero-beta version of the Fama-French model than for any of the other three models. The results, which we will discuss in some detail in the paper, appear below. All returns are in per cent per annum.

Table 1.1
Estimates of the return required on a portfolio of Australian utility stocks

			Betas			Risk Premiums			
Model	Risk-Free Rate*	Zero-Beta Premium	Market	HML	SMB	Market	HML	SMB	Return On Equity
Domestic									
Sharpe-Lintner	3.62		0.52			6.00			6.74
Black	3.62	6.00	0.52			6.00			9.62
Fama-French	3.62		0.65	0.38	0.44	6.00	3.61	2.58	10.03
Zero-Beta FF	3.62	6.00	0.65	0.38	0.44	6.00	3.61	2.58	12.13
International									
Sharpe-Lintner	3.62		0.72			6.00			7.94
Black	3.62	6.00	0.72			6.00			9.62
Fama-French	3.62		0.69	0.29		6.00	3.09		8.66
Zero-Beta FF	3.62	6.00	0.69	0.29		6.00	3.09		10.52

* *Based on the 5 year risk-free rate as published by the Reserve Bank of Australia over the 20 business days in February 2009.*

[1] To calculate the required return on equity we have sampled the same nine energy utilities selected by the Australian Energy Regulator (AER) in its review of the WACC parameters for electricity utilities. The sample includes Australian Gas Light (AGL), Alinta (ALN and AAN), Australian Pipeline Trust (APA), Diversified Utility & Energy Trust (DUET), Envestra (ENV), Hastings Diversified Utilities Fund (HDF), Gasnet (GAS), SP Ausnet (SPN) and Spark Infrastructure (SKI).

The results reflect two empirical regularities. First, estimates of the zero-beta rate always exceed the risk-free rate and so zero-beta models assign higher returns to low-beta assets like utility stocks than models that assume the zero-beta and risk-free rates are equal. Second, utility stocks behave like value stocks and so the Fama-French models assign a higher required return to the stocks.

The remainder of our paper is split into the following four sections:

§ section 2 - we describe the four models we examine in some detail;

§ section 3 - describes the results of estimating the required return to a portfolio of utility stocks using domestic data;

§ section 4 - describes the results of estimating the return using international data; and

§ section 5 - concludes the paper.

1. Pricing Models

The benefits of using a pricing model are that employing the restrictions a model imposes can allow one to compute more precise estimates of required returns. More precise estimates of required returns are useful because more precise estimates will ensure that fewer mistakes are made in allocating capital across different sectors of the economy. The costs of using a pricing model are that the model may be wrong or the data that the model requires one employ may be poor or unavailable. For example, a model that assumes that investors behave myopically can produce biased estimates of required returns if investors do not behave myopically.[2] The use of biased estimates of required returns can lead to a misallocation of capital across sectors of the economy.

This chapter reviews the following financial models that have been used to estimate the required return on equity:

- the Sharpe-Lintner CAPM;
- the Black CAPM;
- the Fama-French model; and
- a zero beta version of the Fama-French model.

1.1. The Sharpe-Lintner CAPM

It is generally accepted that modern portfolio theory originated in the work of Markowitz (1952).[3] It has long been known that it does not pay to put all of one's eggs in one basket. Markowitz examined how one should distribute the eggs one has across baskets. To be precise, Markowitz examined how a risk-averse investor who cares only about the mean and variance of her future wealth should select a portfolio. His insight was that the risk of a portfolio depends largely on how the returns to the assets that make up the portfolio covary with one another and not on how variable the returns are. He emphasised, for example, that a large portfolio of risky assets whose returns are uncorrelated with one another will be virtually risk-free, despite the fact that if any one of the assets were held alone, it would be risky.

In subsequent work, Sharpe (1964) and Lintner (1965) examined how the prices of assets will be determined if all investors choose portfolios that are mean-variance efficient.[4] A portfolio that is mean-variance efficient is a portfolio that has the highest mean return (expected return)

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[2] An investor who behaves myopically is short sighted and only plans one period ahead.

[3] Markowtiz, Harry, *Portfolio selection*, Journal of Finance 7, 1952, pages 77-91.

Markowitz won the Nobel Prize in Economics in 1990 for his work on portfolio theory.

[4] Sharpe, William F., *Capital asset prices: A theory of market equilibrium under conditions of risk*, Journal of Finance 19, 1964, pages 425-442.

Lintner, John, *The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets*, Review of Economics and Statistics 47, 1965, pages 13-37.

Sharpe won the Nobel Prize in Economics in 1990 for his work on how assets are priced.

for a given level of risk, measured by variance of return. Their model has become known as the Sharpe-Lintner CAPM, or often simply the CAPM.

Sharpe and Lintner's insight was that the return that investors will require on an individual asset will be determined not by how risky the asset would be if held alone, but by how the asset contributes to the risk of the market portfolio. A rational risk-averse investor will never invest solely in one single risky asset. In other words, a rational investor will never place all of her eggs in one basket. Instead, she will diversify. So it makes sense that in the Sharpe-Lintner CAPM an investor will care not about how risky an individual asset would be if held alone, but by how the asset contributes to the risk of a large diversified portfolio like the market portfolio.

In the Sharpe-Lintner CAPM risk-averse investors:

(i) choose between portfolios on the basis of the mean and variance of each portfolio's return measured over a single period;

(ii) share the same investment horizon and beliefs about the distribution of returns;

(iii) face no taxes and no transaction costs; and

(iv) can borrow or lend freely at a single risk-free rate.

These assumptions are, of course, unrealistic. Investors almost surely look more than a single period ahead in making their investment decisions. Investors do not share the same beliefs. Investors face taxes and transaction costs and, importantly, investors face lending rates and borrowing rates that differ. This suggests that perhaps the model may incorrectly estimate the required return in practice. Friedman (1952) emphasises, though, that one should judge economic models not by the realism of the assumptions they make but on the accuracy of their predictions.[5] It turns out, however, that not only are the assumptions that the Sharpe-Lintner CAPM makes unrealistic but the predictions that it makes are not entirely accurate. In particular, as we shall see, the model underestimates the mean returns to low-beta assets.

In the Sharpe-Lintner CAPM all investors hold a portfolio that is mean-variance efficient. How efficient a portfolio is can be measured by the portfolio's Sharpe ratio. A portfolio's Sharpe ratio is the ratio of the mean return to the portfolio in excess of the risk-free rate to the portfolio's risk, measured by standard deviation of return.[6] In other words, it is the ratio of what is good about a portfolio to what is bad about the portfolio. A portfolio's Sharpe ratio is a widely used measure of performance.

In the Sharpe-Lintner CAPM, some investors combine the portfolio that has the highest Sharpe ratio with risk-free borrowing while some combine the portfolio with risk-free lending. All investors, though, because they share the same beliefs, hold the same portfolio of risky assets and no other. So, for markets to clear, the portfolio of risky assets that investors hold must be the market portfolio of risky assets.

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5 Friedman, Milton, *The methodology of positive economics*, in Essays in Positive Economics, 1953, The University of Chicago Press, Chicago, IL.

6 The standard deviation of the return to a portfolio is the square root of the variance of the return to the portfolio.

To understand how the Sharpe-Lintner CAPM works, it is useful to consider the following regression:

$$R_j - R_f = a_j + b_j[R_p - R_f] + e_j, \qquad (1)$$

where

R_f = the risk-free rate;

R_j = the return to asset j;

R_p = the return to portfolio p;

e_j = a zero-mean disturbance that is uncorrelated with R_p;

a_j = the intercept of the regression but can also be given an economic interpretation. a_j measures whether adding a small position in asset j to portfolio p will create a new portfolio that has more attractive characteristics. In particular, a_j measures whether adding a small position in asset j to portfolio p will create a new portfolio that has a higher Sharpe ratio than p. If $a_j > 0$ ($a_j < 0$), adding a small position in asset j to portfolio p will create a new portfolio with a higher (lower) Sharpe ratio; and

b_j = the slope coefficient of the regression and it too can be given an economic interpretation. b_j measures the contribution of asset j to the risk, measured by standard deviation of return, of portfolio p. If $b_j > 1$ ($b_j < 1$), adding a small position in asset j to portfolio p will create a new portfolio with more (less) risk, measured by standard deviation of return.[7]

If the market portfolio of risky assets has the highest Sharpe ratio, then one cannot add a position in an asset to the portfolio to create a new portfolio with a higher Sharpe ratio. If one could do so, the market portfolio would not be mean-variance efficient. In other words, it would not have the highest Sharpe ratio. So for every asset j it must be true that the asset's alpha, a_j, computed relative to the market portfolio, m, is zero and

$$\mathrm{E}(R_j) - R_f = b_j[\mathrm{E}(R_m) - R_f], \qquad (2)$$

where

R_m = the return to the market portfolio of risky assets.

This is the Sharpe-Lintner CAPM. In the model, $\mathrm{E}(R_j) - R_f$, the return an investor requires on an asset in excess of the risk-free rate, is a function only of b_j, the asset's beta, and $\mathrm{E}(R_m) - R_f$, the market price of risk or market risk premium. This makes sense because the asset's

[7] An asset's alpha is another widely used measure of performance. An asset's alpha is a sensible measure of performance if one intends to add the asset to a portfolio. It is not a sensible measure of performance if one intends to hold the asset alone. In contrast, an asset's Sharpe ratio is a sensible measure of performance if one intends to hold the asset alone. An asset's Sharpe ratio is not a sensible measure of performance if one intends to add the asset to another portfolio.

beta measures the contribution of the asset to the risk of the market portfolio, the only portfolio of risky assets that investors hold.

Parameters the Sharpe-Lintner CAPM requires	
1.	Risk-free rate
2.	Asset's beta
3.	Market risk premium

The Sharpe-Lintner CAPM is an undeniably elegant model. Although there is plenty of evidence against the model, more sophisticated pricing models against which there is less evidence share an important characteristic with the Sharpe-Lintner CAPM. In these models, as in the Sharpe-Lintner CAPM, the risk of an asset is not measured by the risk of the asset if held alone, that is, by the variability of the asset's return. The risk of an asset is instead measured by how the asset's return covaries with some other quantity or quantities. In the Sharpe-Lintner CAPM, the other quantity is the return to the market portfolio. In the Fama-French three-factor model, the other quantities are the returns to three zero-investment strategies.[8] This link between the Sharpe-Lintner CAPM and more recently developed models explains in part why the Sharpe-Lintner CAPM is typically the first pricing model to which students are introduced in business schools despite the evidence that we shall review against the model.

The Sharpe-Lintner CAPM makes a number of unrealistic assumptions and several authors investigate the impact of relaxing the assumptions. One assumption that is unrealistic is the assumption that the Sharpe-Lintner CAPM makes that investors can borrow and lend freely at a single risk-free rate. The rate at which investors can borrow generally exceeds the rate at which investors can lend. Black (1972), Vasicek (1971) and Brennan (1971) examine the impact of relaxing the assumption that investors can borrow or lend freely at a single rate.[9]

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8 Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, pages 3-56.

A zero-investment strategy is one that requires no investment up front. Any funds invested are borrowed.

9 Black, Fischer, *Capital market equilibrium with restricted borrowing*, Journal of Business 45, 1972, pages 444-454.

Brennan, Michael, *Capital market equilibrium with divergent borrowing and lending rates*, Journal of Financial and Quantitative Analysis 6, 1971, pages 1197-1205.

Vasicek, Oldrich, *Capital market equilibrium with no riskless borrowing*, Memorandum, Wells Fargo Bank, 1971.

1.2. The Black CAPM

Brennan (1971) shows that if one replaces assumption (iv) with:

(v) investors can borrow at a risk-free rate R_b and lend at a risk-free rate $R_l < R_b$,

then

$$\mathrm{E}(R_j) - \mathrm{E}(R_z) = b_j[\mathrm{E}(R_m) - \mathrm{E}(R_z)], \qquad R_l < \mathrm{E}(R_z) < R_b \tag{3}$$

where

$\mathrm{E}(R_z)$ = the mean return to a zero beta portfolio.

Although three authors contributed to the development of the model, Black is usually given the credit for developing it and the model is generally known simply as the Black CAPM. In the Black CAPM investors no longer hold a single portfolio of risky assets, the market portfolio of risky assets, but instead hold combinations of two portfolios of risky assets, the market portfolio of risky assets and the zero-beta portfolio that has least risk. A zero-beta portfolio is a portfolio whose return is uncorrelated with the return to the market.

In the Black CAPM, as in the Sharpe-Lintner CAPM, the excess return an investor requires on an asset is a function of the asset's beta and the market price of risk. In the Black CAPM, though, the excess return is computed using the zero-beta rate, and not the lending or borrowing rate, and, similarly, the market price of risk is the mean return to the market in excess of the zero-beta rate, not the lending or borrowing rate.

It is useful to see how one might be mislead if the Black CAPM were true, but one were to use the lending rate and the Sharpe-Lintner CAPM to compute the required return on an asset. From (2) and (3) the error in computing the return required on an asset if the Black CAPM were true, but one were to use the lending rate and the Sharpe-Lintner CAPM to compute the return would be:

$$[1 - b_j][R_l - \mathrm{E}(R_z)]. \tag{4}$$

Since $R_l < \mathrm{E}(R_z)$, that is, since the lending rate is less than the zero-beta rate, the error will be positive (negative) if $b_j > 1$ ($b_j < 1$). In other words, if the Black CAPM were true, but one were to use the lending rate and the Sharpe-Lintner CAPM to compute the required return on a high-beta asset, one would overestimate the return. On the other hand, if the Black CAPM were true, but one were to use the lending rate and the Sharpe-Lintner CAPM to compute the required return on a low-beta asset, one would underestimate the return. This illustrates that there can be a cost to using a pricing model if the model is wrong.

In estimating the Black CAPM, we follow Velu and Zhou (1999) and assume that the difference between the zero-beta and risk-free rates, what we will call the zero-beta premium, is a constant through time.[10] Thus we examine the following model

$$\mathrm{E}(R_j) - R_f - z = b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}], \tag{5}$$

where

z = the zero-beta premium.

If $z = 0$, the model collapses to the Sharpe-Lintner CAPM illustrating the fact that the Black CAPM is a more general model than the Sharpe-Lintner CAPM. If $z > 0$, as empirically we find, then the Sharpe-Lintner CAPM will underestimate the mean returns to low-beta assets.

Parameters the Black CAPM requires	
1.	Risk-free rate
2.	Zero-beta premium
3.	Asset's beta
4.	Market risk premium

In the Sharpe-Lintner CAPM and the Black CAPM investors behave myopically. In other words, investors never plan more than one period ahead. For example, in determining what portfolio of assets to hold investors, in these models, do not consider whether an asset will pay off well when future investment opportunities are attractive or pay off badly. In practice, investors are likely to view assets that pay off well when future opportunities are attractive as more valuable than assets that pay off badly. If investors hold assets that pay off well when future opportunities are attractive, they will be better able to take advantage of the opportunities. So, all else constant, investors will be willing to pay more for these assets. Thus in determining what return they will require on an asset investors may care about more than just the risk of the asset relative to the market, that is, its beta.

There are a large number of models in the economics and finance literature in which investors do not behave myopically. In these intertemporal models investors at each point in time make investment plans for all future dates contingent on all possible outcomes. The popular Fama-French three-factor model can be viewed as being motivated by the idea that investors do not behave myopically.

10 Velu, Raja and Guofu Zhou, *Testing multi-beta asset pricing models*, Journal of Empirical Finance 6, 1999, pages 219-241.

1.3. The Fama-French Three-Factor Model

Fama and French note that existing evidence indicates that mean returns depend on beta, size and a firm's book-to-market ratio. So they assume that investors care about the exposure of each asset to

(i) the excess return to the market portfolio,

(ii) the difference between the return to a portfolio of high book-to-market stocks and the return to a portfolio of low book-to-market stocks (*HML*) and

(iii) the difference between the return to a portfolio of small cap stocks and a portfolio of large cap stocks (*SMB*).[11]

If this assumption is correct and investors can borrow or lend freely at a single risk-free rate, then one can show that:

$$\mathrm{E}(R_j) - R_f = b_j[\mathrm{E}(R_m) - R_f] + h_j HML + s_j SMB, \tag{6}$$

where

b_j is the slope coefficient from a multivariate regression of R_j on R_m;

h_j is the slope coefficient from a multivariate regression of R_j on *HML*; and

s_j is the slope coefficient from a multivariate regression of R_j on *SMB*.

In their model the required return to an asset depends on more than just its exposure to the market and the market price of risk. The return also depends on the asset's exposure to value and size factors.[12]

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[11] Fama and French do not explicitly make this assumption. In effect, though, they suggest that the model can be derived in this way.

[12] A value stock is the stock of a firm that has a high book-to-market ratio.

Parameters the Fama-French Three-Factor Model requires	
1.	Risk-free rate
2.	Asset's exposure to the market
3.	Asset's exposure to HML
4.	Asset's exposure to SMB
5.	Market risk premium
6.	HML premium
7.	SMB premium

It is important to note that the exposure of asset *j* to the market, b_j, can differ from the asset's beta, b_j. This is because b_j is the slope coefficient from a multivariate regression of R_j on R_m, *HML* and *SMB* whereas b_j is the slope coefficient from a univariate regression of R_j on R_m alone.[13]

The Fama-French three-factor model is now widely used both by academics and practitioners. Fama and French's (1993) paper, for example, was cited 12 times in articles in the Journal of Finance in 2007 whereas Sharpe's (1964) paper was cited just once.

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13 A univariate regression seeks to explain variation in one variable, the dependent variable or regressand, by variation in one other variable, the independent variable or regressor. A multivariate regression seeks to explain variation in one variable by variation in more than one regressor. In a univariate regression the slope coefficient measures the expected impact of an increase in the regressor on the dependent variable. In a multivariate regression the slope coefficient on a regressor measures the expected impact of an increase in the regressor on the dependent variable holding all other regressors constant.

1.4. The Zero-Beta Fama-French Three-Factor Model

We also examine a zero-beta version of the Fama-French three-factor model. In particular, we follow Velu and Zhou (1999) and examine a model in which the difference between the zero-beta and risk-free rates, what we again label the zero-beta premium, is a constant through time.[14] Thus we examine the following model;

$$\mathrm{E}(R_j) - R_f - z = b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}] + h_j HML + s_j SMB, \qquad (7)$$

where

z is the zero-beta premium.

If $z = 0$, the model collapses to the Fama-French three-factor model and so the zero-beta model is more general than the three-factor model. If $z > 0$, as empirically we find, then the Fama-French three-factor model, like the Sharpe-Lintner CAPM, will underestimate the mean returns to low-beta assets. Estimating a zero-beta version of the model fixes the problem.

Parameters the Zero-Beta Fama-French Three-Factor Model requires	
1.	Risk-free rate
2.	Zero-beta premium
3.	Asset's exposure to the market
4.	Asset's exposure to HML
5.	Asset's exposure to SMB
6.	Market risk premium
7.	HML premium
8.	SMB premium

14 Velu, Raja and Guofu Zhou, *Testing multi-beta asset pricing models*, Journal of Empirical Finance 6, 1999, pages 219-241.

2. Empirical Results: Domestic Models

2.1. The Sharpe-Lintner CAPM

The Sharpe-Lintner CAPM predicts that the market portfolio will be mean-variance efficient. Theory suggests that the market portfolio should consist of all assets, not just stocks. Thus theory suggests that the market portfolio should include bonds, real estate and human capital. Measuring the returns to assets other than stocks, though, can be difficult. Corporate bonds are often infrequently traded, the quality of real estate traded changes through time in ways that are difficult to gauge and human capital is rarely traded. For these reasons, most academic work and most practitioners, including regulators, use the return to an index of stocks as a proxy for the return to the market portfolio. So we do so also.

Before we describe the estimates of the return investors require on the equity of an Australian utility that we produce using the model, we briefly summarise the evidence on whether the model correctly prices assets.

2.1.1. Evidence

Fama and French (1992) use US data from 1963 to 1990 and find that contrary to the implications of the Sharpe-Lintner CAPM there is no significant relation between mean return and beta.[15] Figure 1 uses data from 1963 to 2008, taken from Ken French's website, to plot the sample mean excess returns in per cent per annum on 30 US industry portfolios and the US market portfolio against estimates of their betas. Consistent with what Fama and French find, there is no relation between mean return and beta. Also, as many other studies have found, low-beta portfolios have positive alphas.

In the figure, the 30 portfolios are the 10 blue triangles while the market portfolio is the red square. If the Sharpe-Lintner CAPM were true, one would expect the blue portfolio triangles to scatter around the red pricing line. Portfolios with low betas, though, plot above the line and portfolios with high betas plot below the line. The red pricing line is drawn from the origin, the point at which the risk-free asset plots, to the point at which the market portfolio plots. Estimates of the returns required on portfolios that use the Sharpe-Lintner CAPM plot along the line. It follows that an estimate of a portfolio's alpha is the vertical distance from the portfolio, again denoted by a blue triangle, to the red pricing line. The slope of the line provides an estimate of the market price of risk.

While Fama and French use US data, figure 2 uses Australian data from 1979 to 2007, that Lajbcygier and Wheatley (2009) employ, to plot the sample mean excess returns in per cent per annum on 10 portfolios and an index of stocks against estimates of their betas.[16] The 10 Australian portfolios are formed on the basis of past estimates of risk. Every year stocks are allocated to portfolios based on estimates of their betas computed over the previous five years relative to the index. The index is a value-weighted index of Australian stocks. Again, all of

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[15] Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

[16] Lajbcygier, P. and S. Wheatley, Dividend Yields, Imputation Credits and Returns, Working Paper, Monash University, 2009.

the low-beta portfolios have positive alphas. Moreover with these set of portfolios there is a negative relation between mean return and beta.

Figure 1. Plot of mean excess return against beta. US data from 1963 to 2008. Source: Kenneth French.

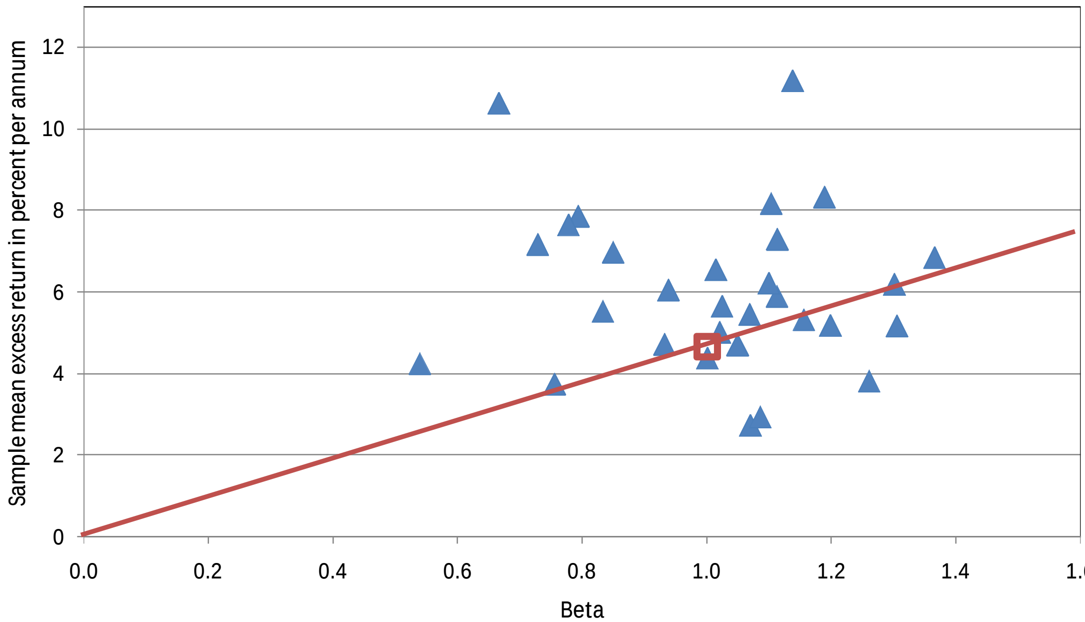
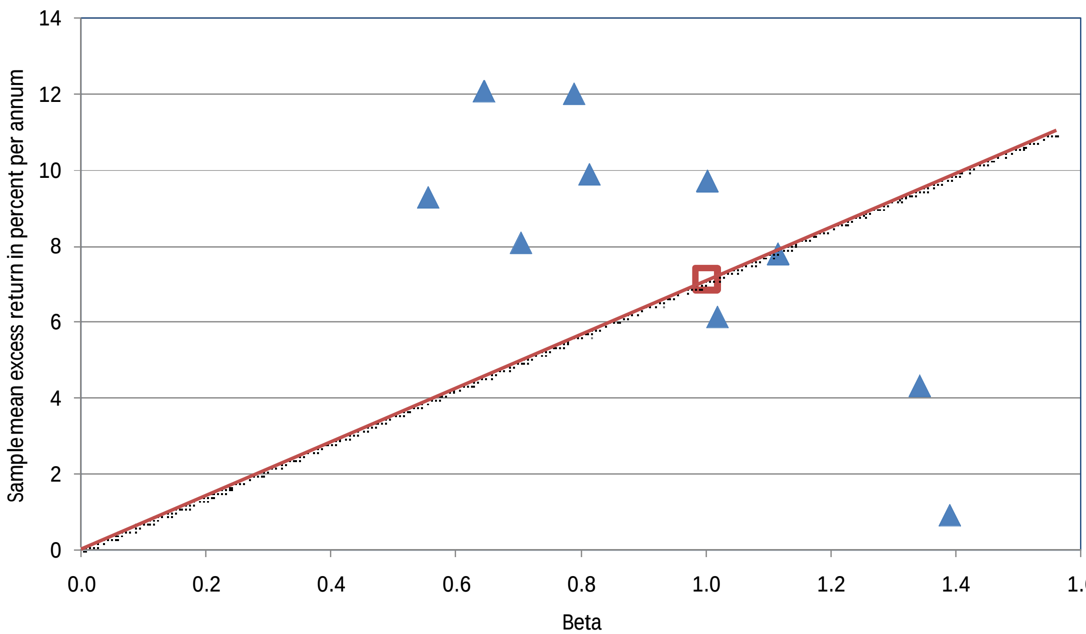


Figure 2. Plot of mean excess return against beta. Australian data from 1979 to 2007. Source: Lajbcygier and Wheatley (2009).



This brief review suggests that while the Sharpe-Lintner CAPM is an attractively simple model, there is quite a lot of evidence that it is not a good predictor of the returns of stocks. In particular, there is evidence that the model underestimates the returns to low-beta stocks.

2.1.2. Estimates

To produce an estimate of the return investors require on the equity of an Australian utility that uses the Sharpe-Lintner CAPM, we require a risk-free rate, an estimate of the beta of the equity and an estimate of the market risk premium. The recent statement issued by the Australian Energy Regulator (AER) indicates that one should use as a measure of the risk-free rate the yield on five-year Commonwealth Government Securities computed over a recent 20-day period.[17] We compute a risk-free rate of 3.62 per cent per annum using data from 2 February 2009 to 27 February 2009 on the yields to five-year Commonwealth Government Securities. The AER's statement also indicates that one should use an estimate of the beta of a utility's equity of 0.8 and an estimate of the market risk premium of 6 per cent per annum. The estimate of the beta of a utility's equity that the AER indicates that one should use is substantially larger than the estimate that we produce when we use a marginally updated version of the data that the AER's own expert Henry employs in his report. Using weekly data from 4 January 2002 to 6 March 2009 on the nine Australian utilities that Henry employs, we compute an estimate of only 0.52.[18]

The AER views the market risk premium as including a fraction, 0.65, of the imputation credits that companies distribute. We view the Australian equity market as being largely integrated with international equity markets and so we believe that the market value of imputation credits is around zero. The empirical evidence that we have recently reviewed also supports this belief.[19] So in this paper we assume that the market value of imputation credits is zero. We continue, though, to use the AER estimate of the market risk premium of 6 per cent per annum since the estimate is largely based on data that precede the introduction of imputation credits.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Sharpe-Lintner CAPM is

$$\mathrm{E}(R_j) = R_f + b_j[\mathrm{E}(R_m) - R_f] = 3.62 + 0.52 \times 6 = 6.74 \text{ percent per annum.}$$

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17 AER, *Electricity transmission and distribution network service providers – Statement of the revised WACC parameters (transmission) – Statement of regulatory intent on the revised WACC parameters (distribution): Proposed (the Proposed WACC Statement)*, December 2008.

18 In its proposed WACC Statement the AER supported a sample period starting from 1 January 2002 to avoid the effect of the 'technology bubble'. See AER, *Electricity transmission and distribution network service providers – Statement of the revised WACC parameters (transmission) – Statement of regulatory intent on the revised WACC parameters (distribution): Proposed (the Proposed WACC Statement)*, December 2008, page 209.

19 NERA, The Value of Imputation Credits: A report for the ENA, Grid Australia and APIA, 11 September 2008.

2.2. The Black CAPM

2.2.1. Evidence

While the Sharpe-Lintner CAPM restricts the zero-beta rate to be the risk-free rate, the Black CAPM does not place this restriction on the parameter. The Black CAPM, however, like the Sharpe-Lintner CAPM, does restrict the return required on an asset to be a positive linear function of its beta computed relative to the market portfolio. If the relation between an asset's return and its beta is linear, then no other variable other than beta should be useful in explaining the cross-section of required returns.

As we have pointed out, Fama and French (1992) use US data from 1963 to 1990 and find that contrary to the implications of the Sharpe-Lintner CAPM there is no significant relation between mean return and beta.[20] They also find that contrary to the implications of the Black CAPM variables besides beta are useful for explaining the cross-section of mean returns. They find, holding beta constant, a positive relation between a firm's book-to-market ratio and the mean return to the firm's equity. That is they find that value stocks deliver higher returns on average than growth stocks on a risk-adjusted basis. They also find, holding beta constant, a negative relation between a firm's market capitalisation and the mean return to the firm's equity. That is, they find that the stocks of small firms outperform the stocks of large firms on a risk-adjusted basis.

The results that Fama and French (1992) find are not unique to the US. Fama and French (1998) find a positive relation between a firm's book-to-market ratio and the mean return to its equity for a large cross-section of countries, including Australia.[21] Since both the Sharpe-Lintner and Black versions of the CAPM predict that the relation between mean return and beta should be linear, the result that size and a firm's book-to-market ratio are better predictors of return than beta provides evidence against both versions of the CAPM. As Fama and French (2004) put it:[22]

> If betas do not suffice to explain expected returns, the market portfolio is not efficient, and the CAPM [either Sharpe-Lintner or Black] is dead in its tracks.

2.2.2. Estimates

To produce an estimate of the return investors require on the equity of an Australian utility that uses the Black CAPM, we require a risk-free rate, an estimate of the zero-beta premium, an estimate of the beta of the equity and an estimate of the market risk premium. Lajbcygier and Wheatley (2009) use Australian data on beta-sorted portfolios and estimate the zero-beta premium to be well in excess of the market risk premium. So to be conservative, we set the zero-beta premium to be equal to the market risk premium of 6 per cent per annum that the

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[20] Fama, Eugene and Kenneth French, *The cross-section of expected returns*, Journal of Finance 47, 1992, pages 427-465.

[21] Fama, Eugene and Kenneth French, *Value versus growth: The international evidence*, Journal of Finance. 53, 1998, pages 975-999.

[22] Fama, Eugene and Kenneth French, *The Capital Asset Pricing Model: Theory and Evidence*, Journal of Economic Perspectives 18, 2004, pages 25-46.

AER indicates one should use.[23] We again use a risk-free rate of 3.62 per cent per annum computed using data from 2 February 2009 to 27 February 2009 on the yields to five-year Commonwealth Government Securities, our estimate of the beta of a utility's equity of 0.52 and an estimate of the market risk premium of 6 per cent per annum.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Black CAPM is

$$\mathrm{E}(R_j) = R_f + z + b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}] = 3.62 + 6 + 0.52 \times [6 - 6] = 9.62 \text{ percent per annum.}$$

2.3. The Fama-French Three-Factor Model

2.3.1. Evidence

It has long been known that small firms earn returns that are too high for the Sharpe-Lintner CAPM to explain. It has also been known for some time that firms with high book-to-market ratios earn returns that are too high for the model to explain. Figure 3 uses data from 1927 to 2008, drawn from Ken French's web site, to illustrate these empirical regularities. The figure uses 25 portfolios formed on the basis of each firm's book-to-market ratio and size. Small high book-to-market firms have had alphas relative to the Sharpe-Lintner CAPM of six per cent per annum over the last 82 years. These firms plot in the middle at the back of the figure.

The Fama-French three-factor model is designed to price small firms and value firms correctly.[24] Figure 4 shows that the abnormal returns that these portfolios deliver relative to the Fama-French model are much smaller. Small high book-to-market firms, for example, have had alphas relative to the Fama-French model of only one per cent per annum over the last 82 years. Again, these firms plot in the middle at the back of the figure.

Again, these results are not unique to US data. O'Brien, Brailsford and Gaunt (2008) find similar results with a shorter time series of Australian data.[25]

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[23] Lajbcygier, P. and S. Wheatley, Dividend Yields, Imputation Credits and Returns, Working Paper, Monash University, 2009.

[24] A value firm is a firm with a high book-to-market ratio.

[25] O'Brien, Michael, Tim Brailsford and Clive Gaunt, *Size and book-to-market factors in Australia*, Electronic copy available at: http://ssrn.com/abstract=1206542.

Figure 3. Plot of Sharpe-Lintner CAPM alpha against book-to-market ratio and size. US data from 1927 to 2008. Source: Kenneth French.

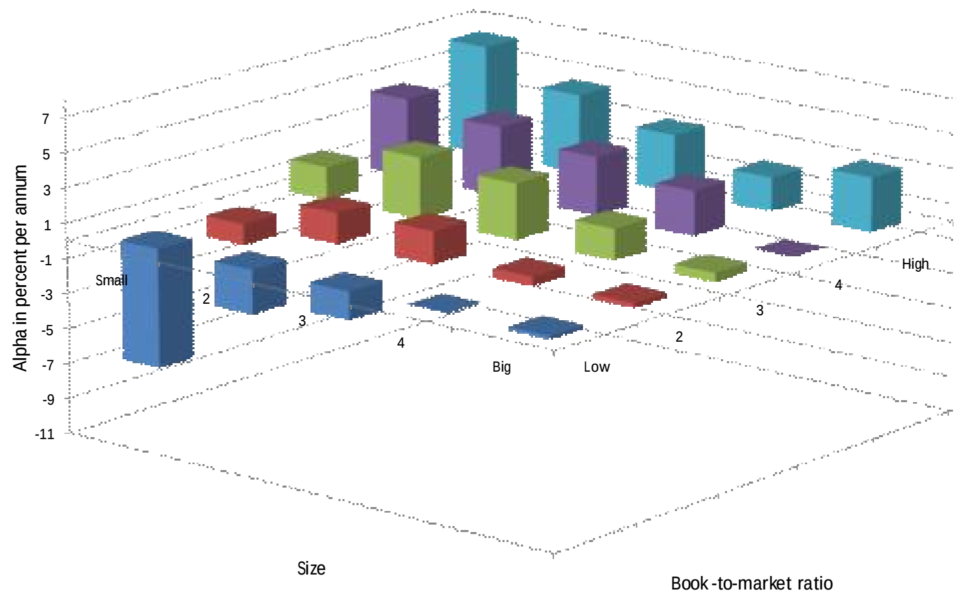
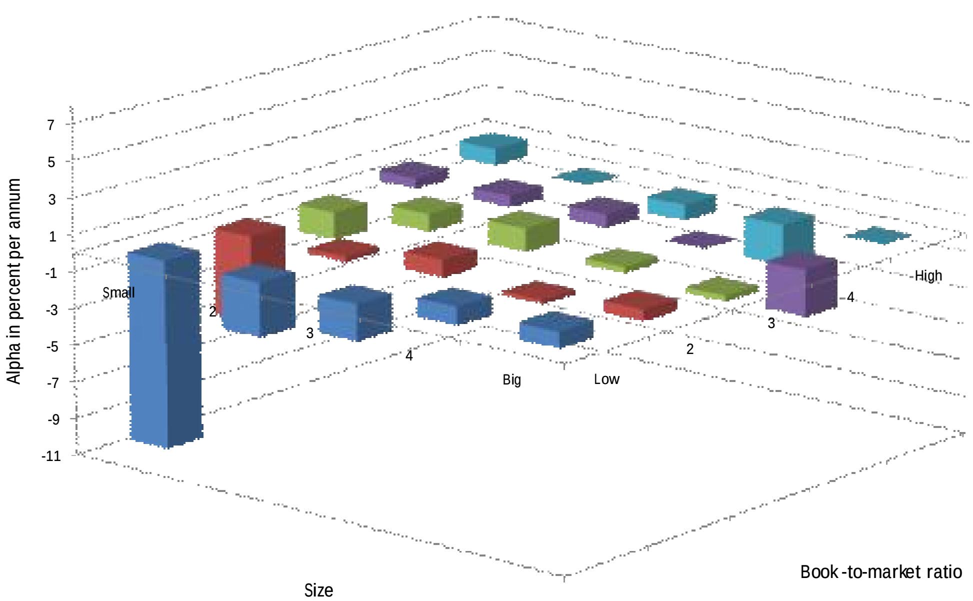


Figure 4. Plot of Fama-French 3-factor alpha against book-to-market ratio and size. US data from 1927 to 2008. Source: Kenneth French.



Both Fama and French (1993) and O'Brien, Brailsford and Gaunt (2008) find that the Fama-French three factor model is better at predicting the returns on stocks than the Sharpe-Lintner CAPM. In other words, both sets of authors find that the Fama-French model tends to produce smaller pricing errors than does the Sharpe-Lintner CAPM. The pricing errors associated with the Fama-French model, however, can be estimated more precisely than their Sharpe-Lintner counterparts. So even though the pricing errors associated with the Fama-French model are smaller than their Sharpe-Lintner counterparts, both sets of authors reject the hypothesis that all of the errors are zero.

2.3.2. Estimates

To produce an estimate of the return investors require on the equity of an Australian utility that uses the Fama-French three-factor model, we require a risk-free rate, estimates of the exposures of the equity to the market, HML and SMB and estimates of the market risk premium and the HML and SMB premiums.

Again we use a risk-free rate of 3.62 per cent per annum computed using data from 2 February 2009 to 27 February 2009 on the yields to five-year Commonwealth Government Securities and an estimate of the market risk premium of 6 per cent per annum. We do not use the estimate of the beta of a utility's equity of 0.8 because the Fama-French model requires that the exposure of the equity to the market be measured using a multivariate and not a univariate regression.

We compute estimates of the three exposures using weekly data from 4 January 2002 to 6 March 2009 on the nine Australian utilities that the AER uses in its recent statement. In computing these exposures we are careful to unlever and relever the exposures to take account of differences between the actual leverage of the nine utilities we examine and the target leverage of 0.6 that the AER lays down. To do this we use the Miles-Ezzell formula that appears on page 18 of Henry's (2008) report that forms an appendix to the AER's recent statement.[26] Our estimates of the exposures of an Australian utility to the market, HML and SMB are 0.65, 0.38 and 0.44 with standard errors of 0.05, 0.06 and 0.07, respectively. These estimates are relatively precise reflecting the use of weekly data and the strength of the relation between the return to the portfolio of Australian utilities and the three Australian factors.

To compute estimates of the HML and SMB premiums, we use a procedure suggested by Anderson (1957) and a combination of monthly Australian data from 1975 to 2008 and US data from 1926 to 2008.[27] Anderson provides a way of using a longer time series to sharpen estimates of the mean of a shorter time series. Here the longer series is provided by the US data and the shorter series is the Australian time series. The use of his procedure provides estimates of the HML and SMB premiums of 3.61 and 2.58 per cent per annum. Despite our use of Anderson's procedure, neither of these estimates is very precise with standard errors of 2.89 and 2.77, respectively.

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[26] Olan Henry, Econometric advice and beta estimation: Report for the Australian Energy Regulator, 28 November 2008.

[27] Anderson, T. W., ***Maximum likelihood estimates for a multivariate normal distribution when some observations are missing***, Journal of the American Statistical Association 52, 1957, pages 200-203.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Fama-French three-factor model is

$$\mathrm{E}(R_j) = R_f + b_j[\mathrm{E}(R_m) - R_f] + h_j HML + s_j SMB$$
$$= 3.62 + 0.65 \times 6 + 0.38 \times 3.61 + 0.44 \times 2.58 = 10.03 \text{ percent per annum.}$$

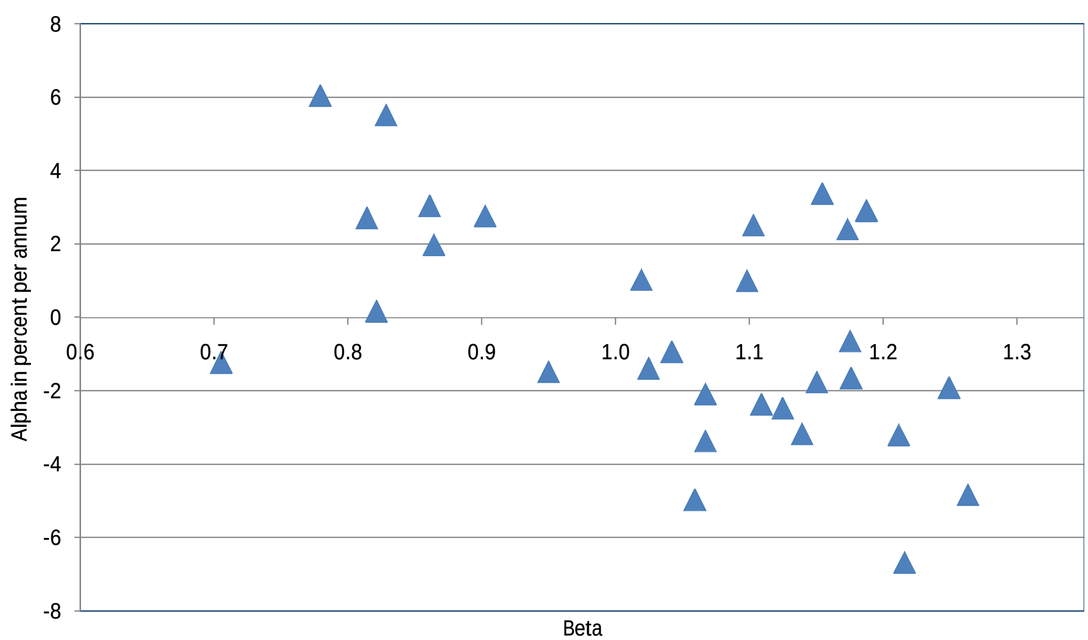
2.4. The Zero-Beta Fama-French Three-Factor Model

The evidence provided by Fama and French (1992) indicates that there is little relation between mean return and beta. The three-factor model that Fama and French (1993) introduce, on the other hand, provides for a positive relation between mean return and beta. It is not surprising then that the Fama-French three-factor model, like the Sharpe-Lintner CAPM, underestimates the returns to low-beta assets. To correct this problem, we also examine a zero-beta version of the three-factor model.

2.4.1. Evidence

Figure 5 illustrates the problem with the three-factor model. The figure plots, for the 30 industry portfolios that figure 1 employs, each portfolio's alpha relative to the Fama-French three-factor model against its Fama-French market beta. Low-beta portfolios tend to have positive alphas whereas high-beta portfolios tend to have negative alphas. Recall that a portfolio's alpha can be viewed as the difference between what the portfolio on average returns and what the model says that it should on average return. So a positive alpha for a portfolio indicates that the model underestimates the mean return to the portfolio.

Figure 5. Plot of Fama-French 3-factor alpha against beta. US data from 1963 to 2008. Source: Kenneth French.



2.4.2. Estimates

To produce an estimate of the return investors require on the equity of an Australian utility that uses the zero-beta version of the Fama-French three-factor model, we require a risk-free rate, an estimate of the zero-beta premium, estimates of the exposures of the equity to the market, HML and SMB and estimates of the market risk premium and the HML and SMB premiums. Thus the only new piece of information that we require is an estimate of the zero-beta premium. Lajbcygier and Wheatley (2009) use Australian data on beta-sorted portfolios and estimate the zero-beta premium again to be well in excess of the market risk premium.[28] So, once more, to be conservative, we set the zero-beta premium to be equal to the market risk premium of 6 per cent per annum that the AER indicates one should use.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the zero-beta version of the Fama-French three-factor model is

$$\begin{aligned} \mathrm{E}(R_j) &= R_f + z + b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}] + h_j HML + s_j SMB \\ &= 3.62 + 6 + 0.65 \times [6 - 6] + 0.38 \times 3.61 + 0.44 \times 2.58 = 12.13 \text{ percent per annum.} \end{aligned}$$

The estimates of the return investors require on the equity of an Australian utility that we compute in this section rely on the assumption that the Australian equity market is segmented from international equity markets. This assumption is not, of course, supported by the evidence.[29] The Australian Bureau of Statistics estimates the total value of equity on issue by Australian enterprise groups as of 30 June 2007 to be AUD 2,195 billion, non-resident holdings to be AUD 632 billion and resident holdings of equity issued by foreign enterprise groups to be AUD 533 billion. The fact that there are substantial foreign holdings of domestic equities and substantial domestic holdings of foreign equities is not surprising. There are few barriers facing Australians who wish to invest in the more developed international equity markets and there are few barriers facing investors from these markets who wish to invest in the Australian equity market.

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28 Lajbcygier, P. and S. Wheatley, Dividend Yields, Imputation Credits and Returns, Working Paper, Monash University, 2009.

29 There is also a lot of evidence that indicates that the US equity market is not segmented from international equity markets.

3. Empirical Results: International Models

In this section we consider four international pricing models. Each model corresponds to one of the models that we examined in the previous section.

3.1. PPP

So far we have operated under the assumption that investors share the same beliefs about the distribution of returns. It is likely, though, that domestic and foreign investors do not share the same beliefs because they care about real returns and not nominal returns and they measure real returns differently. Investors will measure real returns differently if there are deviations from what is known as purchasing power parity (PPP).

PPP says that the cost of living in each country must be the same. Thus PPP says that exchange rate changes are completely explained by inflation differentials. In particular, PPP says that the rate at which the domestic currency depreciates relative to the foreign currency must equal the difference between the domestic inflation rate and the foreign inflation rate. Clearly, PPP is not true.

The theory behind PPP is that deviations from parity in principle cannot occur because these deviations would provide opportunities for agents to earn profits shipping goods from one country to another. In practice, there are costs to shipping goods and countries impose tariffs and so it is not surprising that deviations from PPP occur.

There are pricing models that investigate the impact on the way in which assets are priced of deviations from PPP. In these models deviations from PPP give rise to additional risks. These risks depend on how the returns to assets covary with deviations from PPP. These models, however, typically involve a substantial increase in the number of parameters one must estimate and it is unclear whether the additional risks that are introduced are empirically important. So in what follows we assume that PPP is true, we follow most other authors and measure the returns in US dollars and we assume that there is no inflation in the US.

3.2. Uncovered Interest Rate Parity

To convert the expected US dollar excess return to an asset to an Australian dollar return, we add the Australian risk-free rate to the US dollar excess return. If uncovered interest rate parity holds, then this sum will represent the expected Australian dollar return to the asset. Uncovered interest rate parity says that the rate at which a currency is expected to depreciate relative to another currency is entirely reflected in the difference between the interest rates offered in the two currencies. If, for example, the interest rate on an Australian dollar deposit were 4 per cent over the next year and the interest rate on a US dollar deposit were 1 per cent, then uncovered interest rate parity would predict that the Australian dollar should lose approximately 3 per cent of its value relative to the US dollar over the next year. Although there is plenty of evidence that uncovered interest rate parity does not hold at short horizons, recent work uncovers no evidence against uncovered interest rate parity at the longer horizons with which we are interested.[30]

3.3. Evidence

Fama and French (1998) provide evidence that the Sharpe-Lintner model suffers internationally from the same problem as it does domestically. The model does not price value and growth stocks correctly. Fama and French instead propose a two-factor version of their three-factor model and find that this model does a better job of explaining the cross-section of mean returns than does the Sharpe-Lintner CAPM. The two-factor model drops the SMB factor but retains the HML factor. In the international version of the model, the market portfolio is the world market portfolio and HML is the difference between the returns to globally diversified value and growth portfolios.

3.4. Estimates

3.4.1. Sharpe-Lintner CAPM

To produce an estimate of the return investors require on the equity of an Australian utility that uses the Sharpe-Lintner CAPM, we require a risk-free rate, an estimate of the beta of the equity and an estimate of the market risk premium. We again use a risk-free rate of 3.62 per cent per annum computed using data from 2 February 2009 to 27 February 2009 on the yields to five-year Commonwealth Government Securities.

We compute an estimate of the beta of the equity relative to the world market portfolio using weekly data from 4 January 2002 to 6 March 2009 on the nine Australian utilities that the AER uses in its recent statement. Again, in estimating the beta we are careful to unlever and relever our estimate to take account of differences between the actual leverage of the nine utilities we examine and the target leverage of 0.6 that the AER lays down. Our estimate of the beta of an Australian utility relative to the world market is 0.72. This estimate is relatively precise (it has a standard error of 0.06) reflecting the use of weekly data and the strength of the relation between the return to the portfolio of Australian utilities and the return to the world market portfolio. It is interesting to note that our estimate of the beta of a portfolio of Australian energy utilities is greater when computed relative to the world market (ie, 0.72) than when computed relative to the domestic market (ie, 0.52).

To compute an estimate of the world market risk premium, we use the procedure suggested by Anderson and a combination of monthly data on the return to the world market portfolio taken from Morgan Stanley Capital International from 1970 to 2008 and US data from 1926 to 2008. The use of his procedure provides an estimate of the world market risk premium of 6.46 per cent per annum that is relatively precise. Because the estimate is not significantly different from 6 per cent, though, and because we wish to be conservative, we use the lower figure of 6 per cent per annum.

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30 Chinn, Menzie D. and Guy Meredith, *Testing Uncovered Interest Parity at Short and Long Horizons during the Post-Bretton Woods Era,* International Monetary Fund, Washington DC, 2005.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Sharpe-Lintner CAPM and international data is

$$\mathrm{E}(R_j) = R_f + b_j[\mathrm{E}(R_m) - R_f] = 3.62 + 0.72 \times 6 = 7.94 \text{ percent per annum.}$$

Note that this estimate is only lower than its domestic counterpart because the AER indicates that one should use what is essentially an upwardly biased estimate of beta.

3.4.2. Black CAPM

The Black CAPM requires in addition an estimate of the zero-beta premium. The evidence that Lajbcygier and Wheatley (2009) provide again suggests that the zero-beta premium is no less than 6 per cent per annum. So to be conservative, we choose this figure.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Black CAPM and international data is

$$\mathrm{E}(R_j) = R_f + z + b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}] = 3.62 + 6 + 0.72 \times [6 - 6] = 9.62 \text{ percent per annum.}$$

The estimate is the same as that computed using the Black CAPM and domestic data because in both cases the zero-beta premium is sufficient to exactly offset the market risk premium. In other words, in both cases the Black CAPM assigns the same return to all stocks.

3.4.3. The Fama-French Two-Factor Model

We compute estimates of the two exposures using weekly data from 4 January 2002 to 6 March 2009 on the nine Australian utilities that the AER uses. As before, we are careful to unlever and relever the exposures to take account of differences between the actual leverage of the nine utilities we examine and the target leverage of 0.6 that the AER lays down. Our estimates of the exposures of an Australian utility to the world market and to HML are 0.69 and 0.29. Unfortunately, the HML beta is relatively imprecise with a standard error of 0.19. In future work we may examine daily data in order to sharpen the estimate we compute.

To compute an estimate of the HML premium, we use Anderson's procedure and a combination of monthly international data from 1975 to 2008 and US data from 1926 to 2008. The use of his procedure provides an estimate of the HML premium of 3.09 per cent per annum that is relatively precise with a standard error of 1.03. This reflects in part the strong relation between the international and US HML factors.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Fama-French two-factor model is

$$\mathrm{E}(R_j) = R_f + b_j[\mathrm{E}(R_m) - R_f] + h_j HML$$
$$= 3.62 + 0.69 \times 6 + 0.29 \times 3.09 = 8.66 \text{ percent per annum.}$$

3.4.4. The Zero-Beta Fama-French Two-Factor Model

The zero-beta version of the Fama-French model requires in addition an estimate of the zero-beta premium. The evidence that Lajbcygier and Wheatley (2009) provide again suggests that the zero-beta premium is no less than 6 per cent per annum. So to be conservative, we choose this figure.

It follows that an estimate of the return investors require on the equity of an Australian utility that uses the Black CAPM and international data is

$$\begin{aligned} \mathrm{E}(R_j) &= R_f + z + b_j[\mathrm{E}(R_m) - R_f - \mathrm{z}] + h_j HML \\ &= 3.62 + 6 + 0.69 \times [6 - 6] + 0.29 \times 3.09 = 10.52 \text{ percent per annum.} \end{aligned}$$

4. Conclusions

It will be useful to more closely examine the estimates of the required return that we have computed. So we reproduce here the table that summarizes the results that we have produced.

Table 4.1
Estimates of the return required on a portfolio of Australian utility stocks

			Betas			Risk Premiums			
Model	Risk-Free Rate	Zero-Beta Premium	Market	HML	SMB	Market	HML	SMB	Return On Equity
Domestic									
Sharpe-Lintner	3.62		0.52			6.00			6.74
Black	3.62	6.00	0.52			6.00			9.62
Fama-French	3.62		0.65	0.38	0.44	6.00	3.61	2.58	10.03
Zero-Beta FF	3.62	6.00	0.65	0.38	0.44	6.00	3.61	2.58	12.13
International									
Sharpe-Lintner	3.62		0.72			6.00			7.94
Black	3.62	6.00	0.72			6.00			9.62
Fama-French	3.62		0.69	0.29		6.00	3.09		8.66
Zero-Beta FF	3.62	6.00	0.69	0.29		6.00	3.09		10.52

Regulators currently use a single model, the Sharpe-Lintner CAPM, to determine the required return on capital for gas distributors and transmitters. The evidence indicates, though, that the Sharpe-Lintner CAPM underestimates the returns to low-beta assets and to value stocks. For this reason, we have examined a number of different models to determine whether estimates of the return to the equity of a utility are sensitive to the choice of a model. Our results indicate that the Sharpe-Lintner CAPM may underestimate the return. The mean and median of our estimates are 9.41 and 9.62 per cent per annum. These figures are well over 250 basis points higher than the figure the domestic version of the Sharpe-Lintner CAPM delivers.

There are two reasons why the other models deliver higher returns than the Sharpe-Lintner CAPM. First, the equity of a utility is a low-beta asset and the Sharpe-Lintner CAPM underestimates the return to low-beta assets. Second, our estimates indicate that the equity behaves like a value stock and the Sharpe-Lintner CAPM underestimates the returns to value stocks.

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