Jemena Gas Networks (NSW) - Access Arrangement Information - Appendix 9.1

NERA: Cost of Equity – Fama-French Model

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Cost Of Equity - Fama-French Three-Factor Model
Jemena Gas Networks (NSW)

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Summary and Conclusion

Jemena Gas Networks NSW (JGN) is required to submit a revised access arrangement proposal for its distribution network for the period 2010-2014. A critically important element in determining its revenues during the access period is the allowed return on equity. JGN has engaged NERA Economic Consulting (NERA) together with Simon Wheatley and Jeff Balchin to estimate the current cost of equity for a gas distributor.

The National Gas Law (NGL) and National Gas Rules (NGR) create a regulatory framework that allows a business to recover its efficient costs including a benchmark cost of equity. This benchmark cost needs to reflect the risks of owning equity in a gas distribution business.

There are a number of financial models available to estimate the cost of equity, including the Sharpe-Lintner Capital Asset Pricing Model (CAPM) and the Fama-French three-factor model. The CAPM is the model traditionally employed by Australian regulators including the AER to estimate this cost. The CAPM is one of the simplest available financial models and hypothesises that an asset's risk should be measured by the extent to which it contributes to the risk of the market portfolio.

However, since the CAPM's development in the early 1960's a number of more sophisticated pricing models have been developed that either relax the assumptions of the CAPM and/or attempt to reflect the observed behaviour of investors more closely. One such model that has now gained wide acceptance is the Fama-French three-factor model, which seeks to eliminate the errors with which the CAPM prices value and small stocks.[1] More specifically, this model takes account of the fact that the systematic premium that is earned by a stereotypical value or small stock indicates that value and size are characteristics that proxy for risk for which investors require a return.[2]

The NGR do not require that the AER continue to use the CAPM to determine the return on capital. Rather, the NGR allow a distributor to propose a financial model so long as it complies with the requirements of the NGR and the NGL. In our opinion, the NGR and NGL impose two different types of requirements with respect to the derivation of the rate of return:

§ the outcome of the estimation process be as accurate as possible (but not less than) an estimate of the cost of capital associated with the relevant activity (Rule 87(1), Rule 74(2)(b) and Sections 24(2) and (5) of the NGL); and

§ the financial model that is used to estimate the rate of return be 'well accepted' (Rule 87(2)) and any forecast or estimate be 'arrived at on a reasonable basis' (Rule 74(2)(b)).

In our opinion, the Fama-French three-factor model amply meets these requirements. Specifically, the Fama-French three-factor model demonstrably provides an estimate of the required return that is more accurate than the CAPM. In particular, we note that:

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[1]   A value stock is one for which the ratio of the book value of equity to the market value of equity is high.

[2]   The Australian evidence does not permit a conclusion be drawn that a premium is earned by small stocks. Long-term data from the US, on the other hand, indicate that small stocks earn a premium over large stocks.

§   the weight of empirical evidence suggests that factors other than market beta – namely, the book-to-market ratio of a firm's equity and the market value of a firm's equity – explain the cross-section of mean returns to stocks;

§   a model that takes account of the predictive power of the book-to-market ratio of a firm's equity and a firm's size – namely, the Fama-French three-factor model – better explains the cross-section of mean returns than does the CAPM; and

§   when tested specifically on the returns to energy utilities, the Fama-French three-factor model provides a better estimate of the cost of equity than does the CAPM.

Both the Fama-French three-factor model and the CAPM are well accepted financial models. While the NGR specifically identify the CAPM as an example of a well accepted model, the following evidence indicates that the Fama-French three-factor model is also widely accepted:

§   the Fama-French three-factor model is widely accepted in the academic literature;

§   a sizable proportion of US managers apply multifactor risk models in investment decision-making, with a significant subset of these managers using size and value factors;

§   the investment strategies of Australian active managers allow investors to tilt their portfolios in a manner consistent with the Fama-French three-factor model; and

§   while to our knowledge no regulator is currently using the Fama-French three-factor model to set regulated returns, a number of eminent economic experts engaged by the New Zealand Commerce Commission identified it as an appropriate model to check the allowed returns on equity for regulated companies.

An estimate of the cost of equity for an Australian gas distributor has been computed using a domestic version of the Fama-French three-factor model. Where appropriate, the Fama-French three-factor model has been populated with the same data and parameters as those employed by the AER in its recent review of the *WACC* parameters for electricity lines businesses.[3]

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[3]   The data and parameters include the risk-free rate, the market risk premium, the sample of comparable Australian companies, the use of weekly and monthly data and the estimation period from 1 January 2002 to present.

To estimate parameters not shared with the CAPM, we have primarily used data provided by Dimensional Fund Advisors Australia Ltd (DFA), an investment group affiliated with Fama and French that explicitly invests along the lines suggested by their research. DFA data were used to calculate the:

§   Australian *HML* risk premium; and

§   Australian *SMB* risk premium.

Table 1, sets out the domestic Fama-French three-factor model parameters for a gas distribution business.

Table 1
Domestic Fama-French Three-Factor Model

	Market	*HML*	*SMB*
Risk Premium	6.50%	6.24%	-1.23%
Beta	0.59	0.48	0.30

Estimated using data sampled up to the end of May 2009.

Applying these parameter to a domestic version of the Fama-French three-factor leads to a return on equity that is 6.46 percentage points above the risk-free rate. A risk-free rate of 5.11 per cent was observed over the 20 days up to and including the 29 May 2009, which results in an estimated cost of equity of 11.57 per cent for a gas distributor.

1.   Introduction

This report has been prepared for Jemena Gas Networks NSW (JGN) by NERA Economic Consulting (NERA) with the additional assistance of Simon Wheatley and Jeff Balchin. JGN is the major gas distribution service provider in New South Wales and is required to submit a revised access arrangement proposal for its distribution network for the period 2010-2014 for decision by the Australian Economic Regulator (AER).

JGN proposes that its estimate of the cost of equity capital for application in its access arrangement proposal should be determined using a domestic version of the Fama-French three-factor model. JGN has engaged NERA to provide a report that assesses the merits of the Fama-French three-factor model by reference to the requirements of the National Gas Law (NGL) and National Gas Rules (NGR), and also to estimate the parameters of that model as they would apply to a gas distributor.

Specifically, JGN has requested that we provide an expert opinion on:

1) Comparison with Sharpe-Lintner capital asset pricing model (CAPM) – an assessment of the relative merits of the Sharpe-Lintner CAPM and a domestic version of the Fama-French three-factor model with respect to the National Gas Rules (NGR) and the National Gas Law (NGL), including:

   a) a consideration of the use of the Sharpe-Lintner CAPM by Australian regulators; and

   b) the relative accuracy of the Sharpe-Lintner CAPM and the Fama-French three-factor model in determining the return on equity of a gas distribution business; and

2) Compliance with the NGR and the NGL – an assessment of whether the domestic version of the Fama-French three-factor model complies with:

   a) the NGR, and in particular, rule 87; and

   b) the NGL, and in particular, the pricing principles on efficient costs; and

3) Model specification – specify the form of the domestic version of the Fama-French three-factor model and compare to the Sharpe-Lintner CAPM, including:

   a) a qualitative comparison of the market beta in the Fama-French three-factor model to the equity beta in the Sharpe-Lintner CAPM;

4) Parameter quantification – estimate the parameters of the domestic version of the Fama-French three-factor model that:

   a) apply to a benchmark efficient gas distributor,

   b) are statistically robust and follow best practice estimation methods, and

   c) are suitable for use in support of JGN's cost of equity for the access arrangement review.

The report is structured as follows:

§   Chapter 2 sets out the regulatory framework for estimating the cost of equity of a gas
     distribution business;

§   Chapter 3 discusses the development of the CAPM and the Fama-French three-factor
     model as well as the approach that Australian regulators have previously adopted in
     estimating the cost of equity for regulated energy businesses;

§   Chapter 4 assesses the compliance of the domestic version of the Fama-French three-
     factor model with the NGL and NGR; and

§   Chapter 5 estimates the cost of equity for a gas distribution business using a domestic
     version of the Fama-French three-factor model.

Appendix A sets out the data sources used to estimate the domestic Fama-French three-factor
model, while Appendix B sets out an alternative source of data from which the parameters of
a domestic version of the Fama-French three-factor model can be estimated.

1.1   Statement of Credentials

This report has been jointly prepared by Brendan Quach, **Simon Wheatley**, **Jeff Balchin** and
Greg Houston.

Brendan Quach is a Senior Consultant at NERA with ten years experience as an economist,
specialising in network economics and competition policy in Australia, New Zealand and
Asia Pacific. Since joining NERA in 2001, Brendan has advised a wide range of clients on
regulatory finance matters, including approaches to estimating the cost of capital for
regulated infrastructure businesses.

Simon Wheatley was until recently a Professor of Finance at the University of Melbourne.
Since the beginning of 2008, Simon has applied his finance expertise in investment
management and consulting outside the university sector. Simon's expertise is in the areas of
testing asset-pricing models, determining the extent to which returns are predictable and
individual portfolio choice theory. Prior to joining the University of Melbourne, Simon
taught finance at the Universities of British Columbia, Chicago, New South Wales, Rochester
and Washington.

Jeff Balchin has over fifteen years experience in infrastructure regulation matters across a
wide range of industries, including gas, electricity, water, ports and rail. In this role he has
worked for almost every economic regulator in Australia as well as large consumers of
energy and utility services and infrastructure owners. A key focus of this work has been on
the regulation of revenue and prices, including applying finance theory and practice to the
context of regulation. He has acted as strategic adviser to regulators during price reviews
(including the Victorian Essential Services Commission and the Essential Services
Commission of South Australia), and has authored key reports for the ACCC (including a
2002 report on betas and 2003 report on asset valuation), and has undertaken substantial
finance-related work for infrastructure owners. He has provided expert witness evidence on
access pricing issues in a number of forums in Australia and New Zealand.

Greg Houston is a Director of NERA and head of its Australian operations, while also serving on the Board of Directors and the Management Committee of National Economic Research Associates Inc. Greg has twenty years experience in the economic analysis of markets and the provision of expert advice in litigation, business strategy, and policy contexts. Greg has directed a wide range of competition, regulatory and financial economics assignments since joining NERA in 1989, and has acted as expert witness in finance, competition antitrust and regulatory proceedings before the courts, in various arbitration and mediation processes, and before regulatory and judicial bodies in Australia, Fiji, New Zealand, the Philippines, Singapore and the United Kingdom.

In preparing this report, each of the joint authors (herein after referred to as either 'we' or 'our') confirms that we have made all the inquiries we believe are desirable and appropriate and no matters of significance that we regard as relevant have, to our knowledge, been withheld from this report. We have been provided with a copy of the Federal Court guidelines *Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia* dated 5 May 2008. We have reviewed those guidelines and this report has been prepared consistently with the form of expert evidence required by those guidelines.

2. National Regulatory Framework

> The NGR and the NGL impose two different types of requirements with respect to the derivation of the rate of return, ie:
>
> § the NGL and NGR require the outcome of the estimation process to be as accurate as possible (but not less than) an estimate of the cost of capital associated with the relevant activity – this requirement is implicit in Rule 87(1), explicit in Rule 74(2)(b) and is implied by sections 24(2) and (5) of the NGL; and
>
> § the NGR also places additional requirements on the method that may be used to estimate the various components of the cost of capital – in particular, Rule 87(2) requires that the financial model that is used to estimate the rate of return be 'well accepted', and Rule 74(2)(b) requires that any forecast or estimate be 'arrived at on a reasonable basis'.

This chapter sets out our understanding of the requirements of the National Gas Rules (NGR) and the National Gas Law (NGL) with respect to the choice of the financial model used to determine the required return on equity.

2.1 National Gas Rules and National Gas Law

There is a range of requirements in the NGR and NGL that guide the derivation of the rate of return.

The most directly relevant provision in the NGR is Rule 87. This rule is set out in its entirety below:

(1) The rate of return on capital is to be commensurate with prevailing conditions in the market for funds and the risks involved in providing reference services.

(2) In determining a rate of return on capital:

  (a) it will be assumed that the service provider:

    (i) meets benchmark levels of efficiency; and

    (ii) uses a financing structure that meets benchmark standards as to gearing and other financial parameters for a going concern and reflects in other respects best practice; and

  (b) 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.

In addition, the NGR also specify general requirements that must be met by all forecasts or estimates (Rule 74(2)). The rate of return is both an estimate and a forecast, and so these requirements are relevant; they are as follows:

(2) A forecast or estimate:

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

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

The NGL also sets out a number of principles for revenue and pricing, with those that are directly relevant to the setting of the rate of return, ie, sections 24(2) and (5), providing as follows:[4]

(2) A service provider should be provided with a reasonable opportunity to recover at least the efficient costs the service provider incurs in—

(a) providing reference services; and

(b) complying with a regulatory obligation or requirement or making a regulatory payment.

…

(5) A reference tariff should allow for a return commensurate with the regulatory and commercial risks involved in providing the reference service to which that tariff relates.

Lastly, section 7 of the NGL sets out an objective for the legislative scheme, which is as follows:

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

The criterion of economic efficiency and its outcome in terms of the long-term interests of consumers is generally understood in the area of utility pricing to imply, amongst other things,[5] that firms should have the capacity to recover at least their efficiently incurred costs, including a return on capital that compensates for the opportunity cost of the funds, taking into account the relative risks of the project to which those funds are deployed. This generally understood implication is already reflected in the revenue and pricing principles set out in section 7A of the NGL, and so the implications of the objective are not addressed separately in this report.

2.2 Background to the NGR and NGL Provisions

Prior to discussing the implications of the provisions set out above, it is helpful to review the key characteristics of the task of deriving the rate of return and, relevant to this report, of estimating of the cost of equity.

It is notable that the NGR themselves appear not to specify what the rate of return is supposed to represent; rather, they simply state it should be 'commensurate' with market conditions and the relative risks involved in providing the reference services. This contrasts with the National Electricity Rules, which are clear that the rate of return is intended to be an

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[4]   Sections 24(6) and (7) are also relevant to the rate of return, but are less specific in their advice, and so are not addressed here.

[5]   This objective would also imply that regulated entities should be provided with financial incentives to improve efficiency, including to reduce cost, provide the bundle of services that maximises net benefits to consumers and to set prices that signal the cost of using the network. These additional matters are not relevant to the matters addressed in this report.

estimate of the cost of capital associated with the asset, with the relevant clause stating as follows:[6]

> The rate of return for a Distribution Network Service Provider for a regulatory control period is the cost of capital as measured by the return required by investors in a commercial enterprise with a similar nature and degree of non-diversifiable risk as that faced by the distribution business of the provider …

However, the context in which the reference to the rate of return is used, the reference to the cost of equity and debt and to the Weighted Average Cost of Capital in Rule 87(2)(b) and the requirements of section 24(5) of the NGL all indicate that the intention of Rule 87 is to prescribe that the rate of return be set with reference to an estimate of the cost of capital for the regulated activity (in this case, providing reference services). Section 24(2) of the NGL appears to qualify this further, and implies that the rate of return should not be less than the cost of capital associated with those activities.

The 'cost of capital' associated with an asset has a well accepted meaning in financial economics. It is the return that investors require before they will hold an asset given the asset's risk and the other investment opportunities that are available. The cost of capital can be interpreted as the equilibrium price for investment funds, which is determined by the supply of investment funds and preferences of investors (including the extent to which they are risk averse) and the supply of risky assets (or the demand for investment funds).

The NGR assumes that the cost of capital associated with an asset would be computed by first estimating the returns required by the different providers of funds - namely the providers of equity and debt - and then combining the two estimates into a weighted average cost of capital or *WACC* (Rule 87(2)(b)). This is standard practice. Note, though, that the returns that debt providers require can (in principle at least) be observed from market transactions (such as the issuance of new debt, and the price at which corporate bonds trade),[7] whereas the cost of equity must be estimated. In other words, while the market price for an equity investment can be observed (at least for share market listed entities), the expected return on that investment depends upon the future dividend stream that investors expect, and each investor may have a different opinion.[8] Accordingly, the cost of equity can only be estimated from the information that can be observed (such as share prices, dividend payments, and other factors), which needs to be interpreted through an asset pricing model, as discussed further below.[9]

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[6]   NEL, clause 6.5.2(b).

[7]   Since corporate bonds have a defined stream of future payments (that is, coupon payments and the return of principal), if the price of a bond can be observed at any point in time, the rate of return earned by the bond holder can then be inferred. We note, however, that the 'thinness' of corporate bond markets creates problems with observing the market price of corporate bonds in Australia in practice.

[8]   The value of an equity investment will always be the expected discounted payoff (i.e., distributions of all forms) from the investment.

[9]   It follows that the rate of return (which incorporates the cost of equity) must also be an estimate within the requirements of clause 72(2). Moreover, as the objective is to derive an appropriate rate of return for the next regulatory period, the rate of return that is used must also be a forecast.

The focus of this report is on the estimation of the cost of equity component of the *WACC*. It is taken as given that the alternative to the Fama-French three-factor model for estimating the cost of equity is the Sharpe-Lintner version of the CAPM, since the latter is the model that has been universally applied by Australian regulators in the past. Accordingly, references to the relative performance of the Fama-French three-factor model are made on the understanding that, by virtue of it incumbency, the reference model is the CAPM. Notwithstanding, the Rules do not clearly require the Fama-French three-factor model to be superior to the CAPM, but rather would appear to impose an absolute rather than a relative standard to its evaluation. We discuss this further below, in the context of the 'well accepted criterion'.

2.3 Implications

We noted above that we believe it reasonable to interpret the NGR as saying that the objective for the rate of return is that it should be an estimate of the cost of capital. Moreover, by virtue of section 24(2), the rate of return should be set at a level sufficient for a service provider to recover at least its efficient cost.

In addition, the NGL and NGR impose two different types of requirements with respect to the derivation of the rate of return. First, the NGL and NGR require the outcome of the estimation process to be as accurate as possible (but not less than) an estimate of the cost of capital associated with the relevant activity. This requirement is implicit in Rule 87(1), explicit in Rule 74(2)(b) and is implied by sections 24(2) and (5) of the NGL.

Second, the NGR also places additional requirements on the method that may be used to estimate the various components of the cost of capital. In particular, Rule 87(2) requires that the financial model that is used to estimate the rate of return be 'well accepted', and Rule 74(2)(b) requires that any forecast or estimate be 'arrived at on a reasonable basis'.

Before turning to these different requirements, we discuss the theoretical development of both the CAPM and the Fama-French three-factor model as well as the approach that has been adopted by Australian regulators to estimating the cost of equity for regulated businesses.

3. Development and Application of Models for Estimating the Cost of Equity

The CAPM is one of the simplest available financial models and hypothesises that an asset's riskiness is explained by the extent to which it contributes to the risk of the market portfolio. However, since the CAPM's development in the early 1960's a number of more sophisticated pricing models have been developed that either relax the assumptions of the CAPM and/or attempt to reflect the observed behaviour of investors more closely.

One such model that has now gained wide acceptance is the Fama-French three-factor model, which seeks to better explain the returns one observes to value and small stocks. This model takes account of the fact that the systematic premium that is earned by a stereotypical value or small stock indicates that value and size are characteristics that proxy for risk for which investors require a return.

The CAPM has to date been universally applied by Australian regulators. However, no regulator relies solely on historical Australian financial data to set the parameters of the CAPM. Rather, regulators consider a range of factors, including:

§ the value previously adopted, due to the importance of providing stable and predictable returns to the industry;

§ the equity beta given by other jurisdictional regulators; and

§ international information on equity beta estimates of comparable businesses.

For more than ten years now Australian utility regulators have universally adopted a form of the CAPM to estimate the cost of equity capital for regulated businesses. This chapter reviews:

§ the development of the theoretical frameworks underpinning the CAPM and the Fama-French three-factor model for estimating the cost of equity; and

§ the application of the CAPM in estimating the cost of equity for regulated Australian energy businesses.

3.1 The CAPM and the Fama-French Three-Factor Model

Modern portfolio theory can be traced to the work of Markowitz (1952).[10] It has long been known that it does not pay for an investor to put all of one's eggs in one basket. Markowitz examined how an investor should distribute his or her capital across a portfolio. To be precise, Markowitz examined how a risk-averse investor who cares only about the mean and variance of his or 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 the variance of the returns to individual elements of that portfolio. Markowitz 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, the return would be risky.

3.1.1 Sharpe-Lintner CAPM

Subsequently, Sharpe (1964) and Lintner (1965) examined how the prices of assets will be determined if all investors choose portfolios that are efficient.[11] A portfolio that is efficient is one that has the highest mean return for a given level of risk, where risk is measured by the variance of returns. Their model has become known as the Sharpe-Linter CAPM, or often simply the CAPM.

Sharpe and Lintner's insight was that the return that investors require on an individual asset will be determined not by how risky the asset would be if held alone, but rather by the way in which the asset contributes to the risk of the market portfolio. A rational risk-averse investor will never invest solely in a single risky asset. In other words, a rational investor will never place all of his or her eggs in one basket; rather the investor will diversify. It follows that in the 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.

The CAPM is subject to a number of assumptions about the behaviour of risk-averse investors, ie, they:

(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 (or the same rate of taxation applies to all forms of income) and there are no transaction costs; and

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

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

[11]   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.

The CAPM implies that:

$$E(R_j) = R_f + b_j[E(R_m) - R_f], \tag{1}$$

where

$E(R_j)$ =   is the expected return on asset j;

R_f =   is the risk-free rate;

b_j =   asset j's equity beta, which measures the contribution of the asset to the risk, measured by standard deviation of return, of the market portfolio; and

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

The development of the CAPM represented an important step forward in finance and is the reason that Sharpe was awarded the Nobel Prize in economics in 1990. It should be unsurprising that the CAPM is typically the first pricing model to which students are introduced in business schools, given that it is a simple model that can be used to explain important concepts like diversification and the link between such concepts and the cost of capital and asset pricing. However, notwithstanding its ubiquity in business school texts, there is plenty of empirical evidence that is inconsistent with the predictions of the model, thereby weakening its robustness as a method for estimating the cost of equity.

Perhaps the best known of the early tests of the CAPM are those conducted by Black, Jensen and Scholes (1972).[12] Black, Jensen and Scholes examine the behaviour of the returns to 10 portfolios of US stocks, each formed by reference to past estimates of risk and find evidence against the predictive capabilities of the CAPM. In particular, while Black, Jensen and Scholes found a positive relationship between the equity beta and returns, they found that low equity beta stocks have returns that were higher than predicted by the Sharpe-Linter CAPM, and so had positive 'alphas', while high-equity beta stocks had negative alphas.[13] Fama and French (1992), undertook a similar analysis and found that from 1963 to 1990 there was no significant relation between mean return and the equity beta.[14]

Figure 3.1, illustrates and updates the Fama-French analysis. The figure plots the mean excess returns to 30 US industry portfolios against their equity betas computed relative to the US market from 1963 to 2008. The red line shows the return that the CAPM would predict for a portfolio with a given equity beta, and the blue triangles plot for each portfolio the return that was actually achieved against the portfolio's equity beta. Consistent with the 1992 findings of Fama and French, there is no relation between the mean return of a portfolio and its equity beta. Further, consistent with those findings and the 1972 findings of Black Jensen and Scholes, all of the low-equity beta portfolios have positive alphas.

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[12] Black, Fischer, Michael Jensen and Myron Scholes, *The capital asset pricing model: Some empirical tests*, in Jensen, Michael, (ed.), Studies in the Theory of Capital Markets, 1972, Praeger, New York.

[13] A stock's alpha is the error with which a model measures the expected return to the stock. If a stock has a positive alpha, it means that the model underestimates the expected return to the stock.

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

Figure 3.1
Mean Excess Return Against Equity Beta for
30 US Industry Portfolios: 1963 to 2008
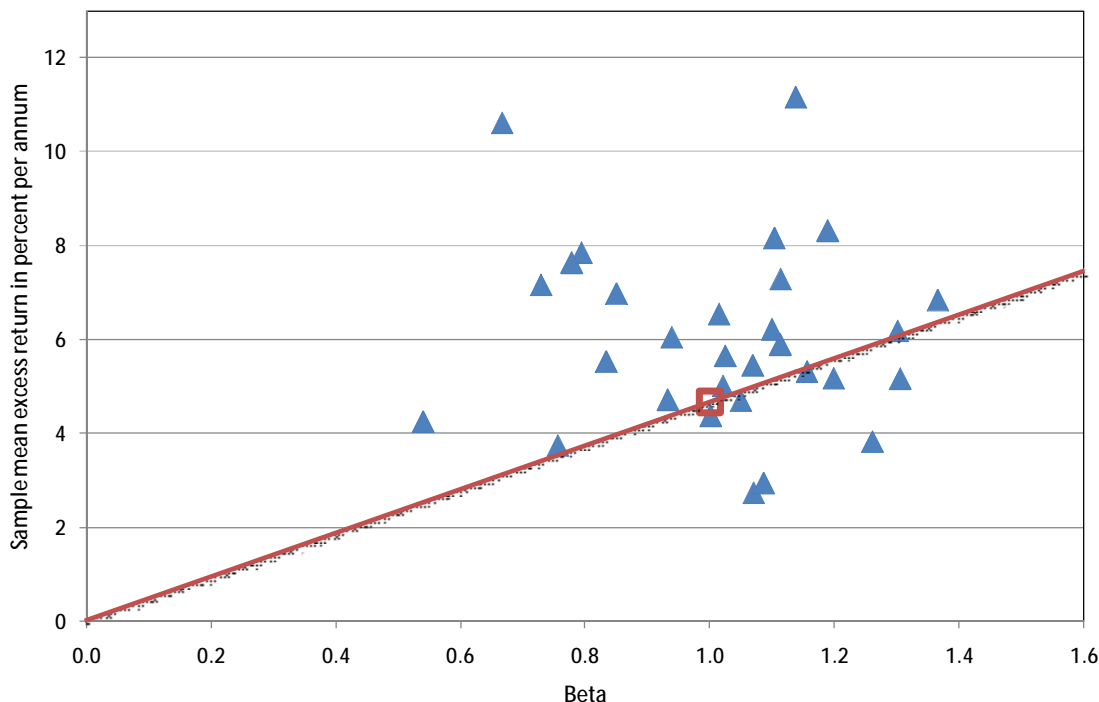
Source: Kenneth French website[15]

A study undertaken by O'Brien, Brailsford and Gaunt (2008) finds similar results for the Australian financial market. Figure 3.2, below, plots mean return against equity beta for the 20 portfolios that they examine that have average market capitalisations above five million dollars.[16]

Although there is plenty of evidence against the CAPM, more sophisticated pricing models against which there is less evidence share an important characteristic with the CAPM. In these models, as in the 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 CAPM, the other quantity is the return to the market portfolio. As discussed in greater detail below, in the Fama-French three-factor model, the other quantities are the returns to three zero-investment strategies.[17]

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[15]   See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[16]   Working Paper presented by O'Brien, Brailsford and Gaunt at the 2008 Australasian Finance and Banking Conference.

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

**Figure 3.2
Mean Excess Return Against Equity Beta for
20 Portfolios of Australian Stocks: 1982 – 2006**
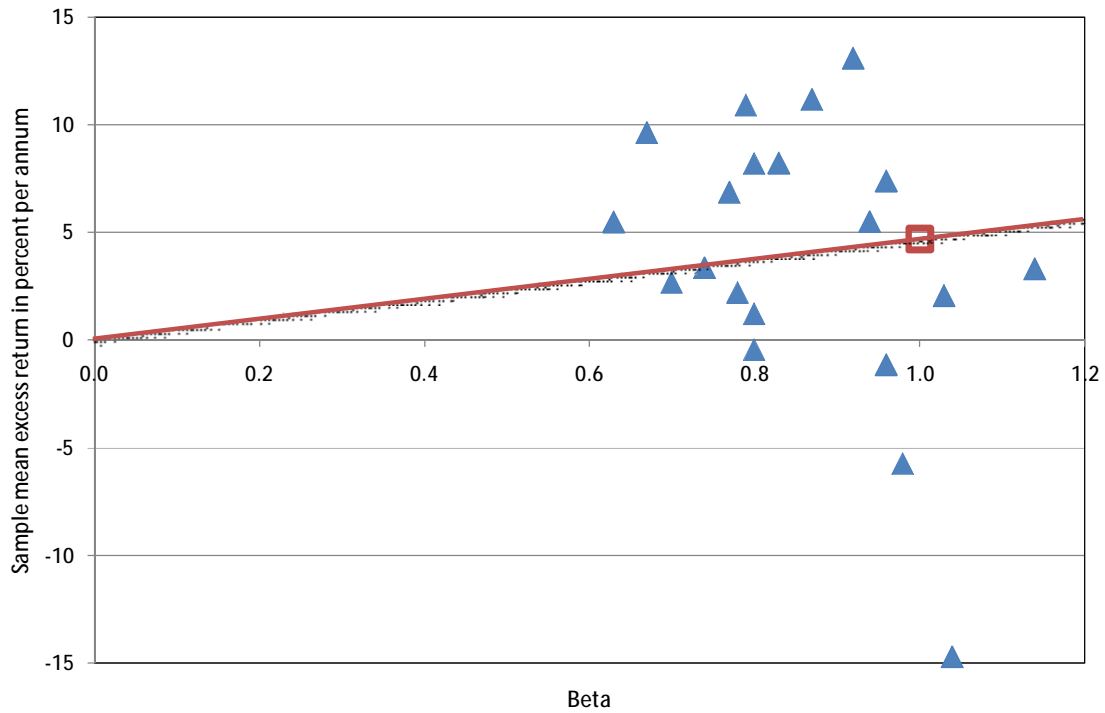
Source: Kenneth French website[18]

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18   See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

## 3.1.2 Fama- French Three-Factor Model

Fama and French (1992) show that the market value of a firm's equity and the ratio of the book value of the equity to its market value are better predictors of the equity's return than is the equity beta.[19]

Figure 3.3 updates the analysis undertaken by Fama and French and plots the CAPM pricing errors (that is, the 'alphas') for the 25 portfolios of US stocks formed on the basis of size and the ratio of the book value of a firm's equity to its market value.

Figure 3.3
Plot of CAPM Alpha for 25 US Portfolios Formed[20]
on the Basis of Size and Book-to-Market Ratio: 1927 – 2008
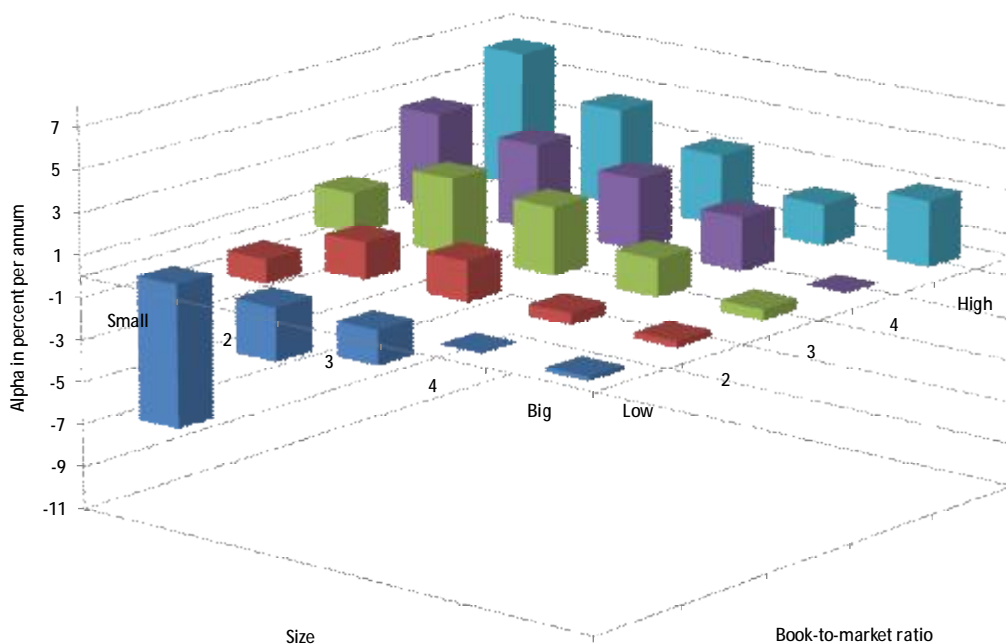
Source: Kenneth French website[21]

Figure 3.3, shows that over the last 82 years a portfolio containing small firms with high book-to-market ratios had a return that was six per cent per annum higher than that explained by the CAPM. Such firms are depicted in the middle at the back of Figure 3.3.

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

[20]   Again, a portfolio's alpha is the error with which a model measures the expected return to the portfolio. If a portfolio has a positive alpha, it means that the model underestimates the expected return to the portfolio.

[21]   See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Fama and French (1993) argue that if assets are priced rationally, variables that can explain the cross-section of mean returns must be proxies for risks that cannot be diversified away about which investors care.[22] In the CAPM, an asset's risk is measured solely by how it contributes to the risk, measured by standard deviation of return, of the market portfolio. In other, more sophisticated models, an asset's risk is measured in addition by the exposure of the asset's return to other factors.

These additional sources of risk can arise because investors care about whether assets are likely to pay off unexpectedly well or badly when future investment opportunities are unexpectedly good. In the CAPM, investors behave myopically. So, in the model, investors do not consider whether an asset will pay off unexpectedly 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 unexpectedly well when future opportunities are attractive, they will be better able to take advantage of the opportunities. So, all else constant, it is likely that, in practice, investors will be willing to pay to accept a lower return on these assets. As Merton (1973) shows, this means that in general risks other than just the risk of an asset relative to the market will be priced.[23]

Another way in which additional risks can be priced is if investors hold assets that are nonmarketable or that they choose not to divest. The CAPM assumes that all assets are marketable and that investors diversify. Heaton and Lucas (2000) note that in practice many large stockholders are the proprietors of small privately held businesses.[24] In other words, many large stockholders choose not to diversify – perhaps to limit agency costs. Events that are likely to adversely affect the values of small-market-capitalisation and value firms, however, are also likely to adversely affect the values of small privately held businesses.[25] So large stockholders who are also proprietors are likely to demand a premium for holding value stocks and may choose to hold portfolios of marketable assets that exhibit a growth tilt.[26]

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

[23] Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica 41, 1973, pages 867-887.

[24] Heaton, John and Deborah Lucas, 2000, *Portfolio choice and asset prices: The importance of entrepreneurial risk*, Journal of Finance 55, pages 1163-1198.

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

[26] Cochrane, John H., *Portfolio advice for a multifactor world*, Economic Perspectives: Federal Reserve Bank of Chicago 23, 1999, pages 59-78.

Finally, as Fama and French (1993) make clear, if there are factors besides the return to the market portfolio that are pervasive, then the Arbitrage Pricing Theory (APT) of Ross (1976) predicts that the additional risks associated with these factors should be priced.[27] To be precise, if the factors are pervasive, the mean return to each asset should be determined by its exposure to the factors. The intuition behind the APT is that investors will be rewarded for risks that are pervasive and they cannot diversify away but will not be rewarded for risks that are idiosyncratic and that they can diversify away.

To explain the patterns in mean returns that one observes, Fama and French (1993) suggest that investors care about the exposure of each asset to:[28]

(i)   the excess return to the market portfolio;

(ii)   the difference between the return to a portfolio of high book-to-market (or 'value') stocks and the return to a portfolio of low book-to-market (or 'growth') stocks (described as 'high minus low', or *HML*); and

(iii) the difference between the return to a portfolio of small cap stocks and the return to a portfolio of large cap stocks (described as 'small minus big', or *SMB*).

If investors care only about the exposure of an asset to these three factors and a risk-free asset exists, then:

$$E(R_j) - R_f = b_j[E(R_m) - R_f] + h_j HML + s_j SMB, \qquad (2)$$

where

b_j, h_j and s_j are the slope coefficients from a multivariate regression of R_j on R_m, *HML* and *SMB*.

The Fama-French three-factor model is designed to explain the returns to (and so to price) small firms and value firms correctly. Figure 3.4 shows that the abnormal returns that the 25 US size and book-to-market sorted portfolios deliver relative to the Fama-French three-factor model are much smaller. For example, small, high book-to-market firms have exhibited returns in excess of that predicted by the Fama-French three-factor model of only one percent per annum over the last 82 years. Again, such firms are depicted in the middle at the back of Figure 3.4.

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[27]   Fama, Eugene and Kenneth French, *Common risk factors in the returns to stocks and bonds*, Journal of Financial Economics 33, 1993, page 35.

Ross, Stephen, *The arbitrage theory of capital asset pricing*, Journal of Economic Theory 13, pages 341-360.

[28]   Merton, Robert C., *An intertemporal capital asset pricing model*, Econometrica 41, 1973, pages 867-887.

Figure 3.4
Plot of Fama-French Three-Factor Model Alpha for 25 Portfolios Formed[29]
on the Basis of Size and Book-to-Market Ratio: 1927 – 2008
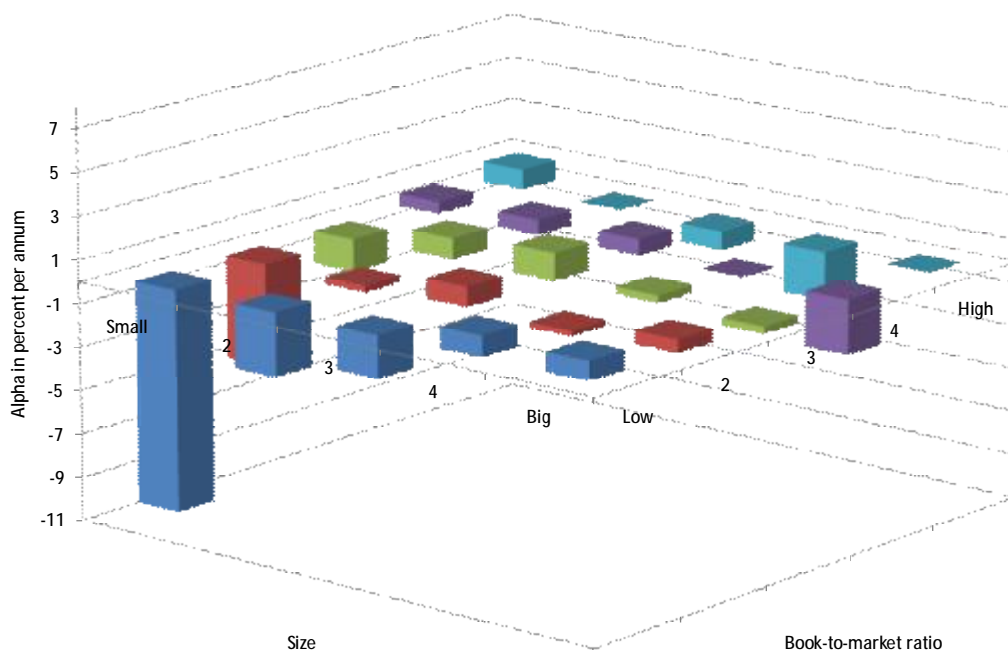
Source: Kenneth French website[30]

The R^2 values attached to the time series regressions of the returns to the 25 US portfolios on the three factors that Fama and French (1993) report range from 0.83 to 0.97. Thus, as Cochrane (2001) points out, the three-factor model must be approximately true to avoid near-arbitrage opportunities.[31] If the R^2 values were all equal to 1.00, the three-factor model would have to hold exactly to rule out arbitrage opportunities.

Similar results have been found with Australian data. For example, Gaunt (2004) and O'Brien, Brailsford and Gaunt (2008)[32] have found that the abnormal returns relative to the Fama-French three-factor model delivered by 25 similarly constructed Australian portfolios are smaller than the abnormal returns the portfolios deliver relative to the CAPM.[33] The R^2

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[29]   A portfolio's alpha is the error with which a model measures the expected return to the portfolio.

[30]   See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[31]   Cochrane, John H., *Asset pricing*, Princeton University Press, 2001, page 442.

[32]   Gaunt, Clive, *Size and book to market effects and the Fama-French three-factor asset pricing model: Evidence from the Australian stock market*, Accounting and Finance 44, 2004, pages 27-44.

       O'Brien, Michael A., Tim Brailsford and Clive Gaunt, *Size and Book-to-market Factors in Australia*, 2008, Paper presented at the 2008 Australasian Finance and Banking Conference.

[33]   The Australian data that Gaunt and O'Brien, Brailsford and Gaunt assemble run from 1982 to 2006, a period that is less than one third as long as the period Fama and French's US data cover.

values attached to the time series regressions of the returns to the 25 Australian portfolios on the Australian Fama-French factors, on the other hand, are lower than their US counterparts. They range from 0.48 to 0.89. Most exceed 0.70, though, so, while lower than their US counterparts, they are still high.

In the following section we discuss the use of financial models by Australian regulators.

3.2   Use of the CAPM by Australian Regulators

In Australia, investors face taxes on capital gains and dividends but also receive imputation credits. Officer (1994) derived a version of the CAPM in which imputation tax credits can reduce the return the market requires from firms.[34] The Officer form of the CAPM maintains assumptions (i), (ii), and (iv) set out above. However, instead of assumption (iii) it assumes that:

(v)   investors may be taxed differently but each investor faces the same rate of tax on capital gains and dividends; imputation credits are attached to the dividends that some assets deliver, that some investors can redeem for cash; and investors face no other taxes and no transaction costs

Under this assumption, investors receive returns in three forms, ie, as capital gains, as dividends and as imputation credits. The assumption that each investor faces the same rate of tax on capital gains and dividends implies that these taxes will not affect the investor's decision about what portfolio to hold. An investor's ability to use imputation credits, though, will affect his or her portfolio choice. All else constant, one would expect investors who can use the imputation credits to hold portfolios more heavily weighted with assets with high imputation credit yields and investors who cannot use the credits to hold portfolios more heavily weighted with assets with low imputation credit yields. It follows that, in principle, this model can explain why Australian investors hold portfolios heavily weighted with Australian stocks. This is because Australian investors can use imputation credits while foreign investors cannot easily use the credits.

Australian utility regulators have consistently used Officer's model to determine the cost of equity for regulated businesses. One of the first such applications of the CAPM was in 1998 by the then Office of Regulator-General Victoria (ORG)[35] to establish the cost of equity for the Victorian gas distribution businesses.[36]

The ORG established the use of Australian domestic data to estimate both the risk-free rate and the market risk premium, ie:

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[34]   Officer, Robert R., *The cost of capital of a company under an imputation tax system*, Accounting and Finance, 1994, pages 1-17.

[35]   Note that the Office of Regulator-General Victoria was renamed the Essential Services Commission of Victoria (ESCV) on the 1 January 2002.

[36]   ORG, *Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar (Assets) Pty Ltd, Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd: Final Decision*, October 1998.

§   the risk-free rate was estimated using a recent sample of ten-year Commonwealth Government bonds yields;[37] and

§   a market risk premium of 6 per cent was established primarily from the historical excess returns (including the market value of distributed imputation credits) of the Australian equities market over the Government bond yields, and also on the basis of the opinions of Australian market practitioners. [38]

These values have generally been adopted by all Australian regulators in subsequent regulatory decisions.[39]

However, the ORG was unable to rely on Australian domestic data to estimate the equity beta of Victorian gas distribution businesses. The ORG stated that:[40]

> Notwithstanding the large volume of information, analysis and views now on the public record in relation to the beta value for Victorian gas distribution businesses, there is very little if any objective market data available currently in Australia on which to base empirical estimates of this key parameter in the *WACC* estimation for those businesses.

In light of the paucity of Australian market data, the ORG based its decision to set an equity beta of 1.2 by reference to the findings of the UK Monopolies and Mergers Commission's estimate of the asset beta of Transco, the UK gas transmission company.

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[37]   ORG, *Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar (Assets) Pty Ltd, Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd: Final Decision*, October 1998, pages 200-2001.

[38]   ORG, *Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar (Assets) Pty Ltd, Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd: Final Decision*, October 1998, page 203.

[39]   We note that both IPART and ESCV decisions have incorporated a range for the MRP that includes 6 per cent, while the AER's recent review of WACC parameters for the electricity industry set a MRP of 6.5 per cent.

[40]   ORG, *Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar (Assets) Pty Ltd, Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd: Final Decision*, October 1998, page 75.

Since 1998 the availability of Australian market data has improved as the number of Australian listed regulated energy businesses has increased. Consequently, subsequent regulatory decisions have increasingly referred to Australian market data. Since the ORG's decision in 1998, for example:

§   in 2002 the Essential Services Commission of Victoria (ESCV) found that capital market data suggested an equity beta value of 0.55;[41]

§   in 2003 the Australian Competition and Consumer Commission (ACCC) estimated that domestic financial data suggested that the average re-levered equity beta ranged between 0.17 and 0.30 for its core sample of firms;[42]

§   in 2005 the Independent Pricing and Regulatory Tribunal (IPART) estimated that the average equity beta of a comparable regulated energy business was 0.3;[43] and

§   in 2006 the Essential Services Commission of South Australia (ESCOSA) found that domestic financial data suggested a range for the equity beta of between 0.21 and 0.37 (depending on the estimation frequency and period).[44]

However, no regulator has relied solely on historical Australian financial data to set the equity beta of a regulated business. Instead regulators have considered a range of factors, in addition to historical domestic financial data, when setting the equity beta including:

§   the value previously adopted, due to the importance of providing stable and predictable returns to the industry;[45]

§   the equity beta given by other jurisdictional regulators;[46] and

§   international information on equity beta estimates of comparable businesses.[47]

By considering a range of factors, and not relying exclusively on domestic financial data, jurisdictional regulators have set an equity beta of between 0.8 and 1.1, for gas and electricity businesses.

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[41]   ESCV, *Review of Gas Access Arrangements: Final Decision*, October 2002, page 140.

[42]   ACCC, *Review of the Draft Statement of Regulatory Principles for the Regulation of Transmission Revenues: Discussion Paper,* August 2003, page 79.

[43]   Average of the December 2004 re-levered equity betas in table 8.5, IPART, *Revised Access Arrangements for AGL Gas Networks*, April 2005, page 101.

[44]   ESCOSA, *Proposed Revisions to the Access Arrangements for the South Australian gas Distribution System: Draft Decision*, March 2006, page 69 and 252.

[45]   See AER, *Revised Access Arrangement by GasNet Australia (Operations) Pty Ltd and GasNet (NSW) Pty Ltd for the Principal Transmission System*, 30 April 2008, page 67, and ESCV, *Review of Gas Access Arrangements: Final Decision*, October 2002, page 140.

[46]   See QCA, Revised Access Arrangements for Gas Distribution Networks – Envestra: Final Decision, May 2006, page 103, and ESCV, *Electricity Distribution Price Review 2006-10 – Vol 1 Statement of Purpose and Reasons: Final Decision*, October 2005, page 356.

[47]   See ESCOSA, 2005-*2010 Electricity Distribution Price Determination – Part A – Statement of Reasons, April 2005*, page 142, and ESCV, *Electricity Distribution Price Review 2006-10 – Vol 1 Statement of Purpose and Reasons: Final Decision*, October 2005, page 356.

The use of regulatory discretion in determining the equity beta was also evident in the Australian Energy Regulator's (AER's) recent review of the weighted average cost of capital (*WACC*) parameters for electricity lines businesses. The AER conducted an extensive study of the equity beta of regulated energy businesses using recent current domestic financial data. The AER concluded that the financial data indicated that the equity beta of a benchmark efficient network service provider ranged between 0.41 and 0.68.[48] However, in determining an equity beta of 0.8 the AER stated:[49]

> Market data suggests a value lower than 0.8. However, the AER has given consideration to other factors, such as the need to achieve an outcome that is consistent with the importance of regulatory stability.

The following section discusses the choice of financial model to estimate the cost of equity in the context of the National Gas Rules and Law, and the provisions that allow regulators to place a greater reliance on domestic financial data.

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[48]   AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 343.

[49]   AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 343.

4. Requirements of the National Gas Rules and Law

The Fama-French three-factor model amply meets the requirements of the NGR and NGL, because:

§ it demonstrably provides an estimate of the required returns that is more accurate than the CAPM, since:

– the weight of empirical evidence suggests that factors other than market beta explain the cross-section of mean returns to stocks – namely, the book-to-market ratio of a firm's equity and the market value of a firm's equity;

– a model that takes account of the systematic predictive power of the book-to-market ratio and size of a firm – namely, the Fama-French model – provides a better estimate of the cost of equity than the CAPM; and

– when tested on the returns to energy utilities, the Fama-French three-factor model substantially reduces the pricing errors associated with the CAPM.

§ the Fama-French three-factor model is a well accepted financial model, since:

– it has gained wide acceptance in the academic literature;

– in the US, a sizable proportion of managers apply multifactor risk models in investment decision-making, with a significant subset of these managers using size and value factors;

– Australian investment portfolios are more consistent with the predictions of the Fama-French three-factor model than with the predictions of the CAPM since investors do not all hold the same portfolio of assets – rather the evidence indicates that different investors hold different portfolios;

– furthermore, the investment strategies of active managers allow investors to tilt their portfolios in a manner consistent with the Fama-French model; and

– whilst to our knowledge no regulator is currently using the Fama-French three-factor model to set regulated returns, a number of eminent economic experts engaged by the New Zealand Commerce Commission identified it as an appropriate model to check the allowed returns on equity for regulated companies.

This chapter addresses the question of whether the Fama-French three-factor model complies with the National Gas Rules (NGR) and the National Gas Law (NGL). In chapter 2, we conclude that the NGL and NGR impose two different types of requirements with respect to the derivation of the rate of return, ie:

§ the NGL and NGR require the outcome of the estimation process to be as accurate as possible (but not less than) an estimate of the cost of capital associated with the relevant activity – this requirement is implicit in Rule 87(1), explicit in Rule 74(2)(b) and is implied by sections 24(2) and (5) of the NGL; and

§   the NGR also places additional requirements on the method that may be used to estimate
    the various components of the cost of capital – in particular, Rule 87(2) requires that the
    financial model that is used to estimate the rate of return be 'well accepted', and
    Rule 74(2)(b) requires that any forecast or estimate be 'arrived at on a reasonable basis'.

These different requirements are discussed in turn below.

4.1   Does the Fama-French Three-Factor Model Provide an Accurate Estimate of the Cost of Equity?

The requirement for the selected financial model to produce an accurate estimate of the cost
of equity would appear to require an assessment of the performance of the selected model
compared to viable alternatives. All models for estimating the cost of equity are imperfect
descriptions of the preferences of investors and how markets function in practice and hence
any model for estimating required returns will be imperfect, and so none can claim to be
perfectly accurate. It follows that the task becomes one of selecting the model that produces
the most accurate estimate, which in practice means a more accurate estimate than viable
alternatives. Since Australian regulators have universally applied a form of the CAPM, we
take the viable alternative to the Fama-French three-factor model to be the CAPM.

Section 3.1 above reviews the empirical evidence on the predictive accuracy of the CAPM
relative to the Fama-French three-factor model. The conclusions of that work can be
summarised as follows. First, the weight of empirical evidence suggests that factors other
than equity beta explain the cross-section of mean returns – namely the book-to-market ratio
and market capitalisation of a firm's equity. While the bulk of empirical research as to the
predictive performance of different models has been undertaken in the US, we note that:

•   the relationships hypothesised by the Fama-French three-factor model have been found in
    a number of different time periods in the US and, in particular, the results have been
    replicated in samples outside of that used in the original analysis (see, for example, Davis,
    Fama and French (2000));[50]

•   the same relationships have been found in other major capital markets, namely in Europe,
    the UK and Japan (see, for example, Chan, Hamao and Lakonishok (1991));[51] and

§   as will be demonstrated in chapter 5, for the longest period over which Australian book-
    to-market data are available (ie, January 1975 to May 2009) statistically higher returns
    have been achieved by Australian value stocks (ie, those with high book-to-market ratios)
    than can be explained by the CAPM, although it is less clear that the size factor has been
    priced in Australia.

Our discussion of the respective performance of the CAPM and the Fama-French three-factor
model noted that the fact these factors are observed to have a systematic relationship with

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[50]   Davis, James, Eugene Fama and Kenneth French, *Characteristics, covariances, and average returns: 1929-1997*,
       Journal of Finance 55, 2000, pages 389-406.

[51]   Chan, Louis K. C., Yasushi Hamao and Josef Lakonishok, *Fundamentals and Stock Returns in Japan*, Journal of
       Finance 46, 1991, pages 1739-1764.

equity returns implies that the factors must proxy for additional sources of undiversifiable risk. These additional sources of risk warrant a higher return. It follows that a model for estimating the cost of equity that recognises these additional sources of risk should provide a more accurate estimate of the cost of equity.

Second, consistent with this, the weight of empirical research also suggests that a model that takes account of the systematic predictive power of a firm's book-to-market ratio and size – namely, the Fama-French three-factor model – provides a better estimate of the cost of equity that the CAPM. In other words, the Fama-French three-factor model explains some of the 'anomalies' that cannot be explained by the CAPM.

Finally, we have tested the accuracy of the Fama-French three-factor model relative to the CAPM for energy utilities. To construct a test that has some power to reject a model requires not only a large number of listed companies within the sector but also a long time series of returns. Ideally, such a test would examine both the CAPM and the Fama-French three-factor model using Australian financial data. The Australian financial market, though, contains only a limited number of regulated energy infrastructure businesses and these typically have only been listed for a short period of time. In contrast, a large number of gas and electricity utilities have been listed on US financial markets for a number of decades.

We have therefore tested the two models using monthly US financial data. Our sample runs from August 1980 to May 2009 and the data we use are from Bloomberg. Table 4.1 below lists the US gas and electricity utilities included in the portfolio we form to test the explanatory power of the two models.

Table 4.1
US Energy Utilities

Company	Ticker	Industry
ITC Holdings Corp	ITC	Electricity
NV Energy Inc	NVE	Electricity
UIL Holdings Corp	UIL	Electricity
CH Energy Group Inc	CHG	Electricity and Gas
Centerpoint Energy Inc	CNP	Electricity and Gas
Consolidated Edison Inc	ED	Electricity and Gas
Energy East Corp	EAS	Electricity and Gas
Pepco Holdings Inc	POM	Electricity and Gas
NiSource Inc	NI	Electricity and Gas
New Jersey Resources Corp	NJR	Electricity and Gas
NSTAR	NST	Electricity and Gas
Northeast Utilities	NU	Electricity and Gas
AGL Resources Inc	AGL	Gas
Atmos Energy Corp	ATO	Gas
The Laclede Group Inc	LG	Gas
Nicor Inc	GAS	Gas
Northwest Natural Gas Co	NWN	Gas
Piedmont Natural Gas Co Inc	PNY	Gas
South Jersey Industries Inc	SJI	Gas
Southwest Gas Corp	SWX	Gas
WGL Holdings Inc	WGL	Gas

*UBS Transmission & Distribution (T&D) Utilities (US). Note that individual securities data is
sourced from Bloomberg.*

To remove the impact of company-specific gearing levels, the returns of firms in the sample
were de-levered and then re-levered to a benchmark gearing ratio of 60 per cent. The re-
levered return to security j is calculated using the following formula:

$$\hat{R}_j = \left(\frac{1-L_j}{1-0.6}\right)R_j + \left(1-\left(\frac{1-L_j}{1-0.6}\right)\right)R_f \qquad (3)$$

where

$\hat{R}_j$ is the re-levered return to the security j;

R_j is the un-levered return to the security j;

L_j is the actual debt-to-value ratio of the security j; and

R_f is the risk-free return.

The re-levered returns of the above sample of listed US gas and electricity utilities have then
been used to create the following two portfolios:

§ an equally weighted portfolio, ie, each month's return to the portfolio is the arithmetic
average of the returns in the sample of US gas and electricity utilities for that month; and

§   a value-weighted portfolio, ie, each month's return to the portfolio is the market-capitalisation weighted average of the returns in the sample of US gas and electricity utilities for the month, where the market capitalisation is determined at the start of the month.

Since our data are monthly, we use the one-month US Treasury bill return as a proxy for the risk-free rate, rather than a long-term bond yield. Data on the market returns, one-month Treasury bill returns, and *HML* and *SMB* factors are drawn from Ken French's website.[52]

Table 4.2 provides estimates of the betas of the portfolio of utilities relative to the market alone and relative to the three Fama-French factors together and estimates of the alpha (unexplained excess return) for each pricing model. The alphas for the CAPM and Fama-French three-factor model are given by

$$a_{\mathrm{j}} = \mathrm{E}(R_j) - R_f - b_j[\mathrm{E}(R_m) - R_f], \tag{4}$$

$$a_{\mathrm{j}} = \mathrm{E}(R_j) - R_f - b_j[\mathrm{E}(R_m) - R_f] - h_j HML - s_j SMB \tag{5}$$

Alpha is a measure of the extent to which a model misprices an asset. An estimate of an alpha that is significantly different from zero provides evidence against a model.

The results of our analysis are set out below in Table 4.2.

Table 4.2
Performance of the Models for Portfolios of US Energy Utilities

Portfolio	Alpha	Equity Beta	Exposure		
			Market	**HML**	**SMB**
CAPM					
Equally Weighted Portfolio	8.19	0.47			
	(2.72)	(0.05)			
Value-Weighted Portfolio	7.16	0.36			
	(3.95)	(0.07)			
Fama-French Model					
Equally Weighted Portfolio	4.24		0.67	0.66	-0.10
	(2.44)		(0.05)	(0.07)	(0.07)
Value-Weighted Portfolio	4.34		0.56	0.67	-0.22
	(3.48)		(0.07)	(0.10)	(0.09)

Alpha is in percent per annum. Standard errors are in parentheses.

Table 4.2 shows that the alphas of both portfolios relative to the CAPM are statistically significant, and material in economic terms. Put another way, over the assessment period (ie, 1980 to 2009) the CAPM would have substantially underestimated the returns achieved for a portfolio of US gas and electricity utilities.

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[52]   See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The alphas of both portfolios relative to the Fama-French three-factor model are also both material in economic terms. However, they are only about half the size of their CAPM counterparts, and so are not statistically significant at conventional (5 per cent) levels. It follows that our analysis indicates that the Fama-French three-factor model is a better predictor of the required returns on a portfolio of US gas and electricity utilities than is the CAPM.

Our analysis of US regulated gas and electricity utilities gives rise to two conclusions, ie:

§ that the CAPM underestimates the returns on US regulated gas and electricity utilities; and

§ that the Fama-French three-factor model is a better predictor of the returns required on a portfolio of US gas and electricity utilities than is the CAPM

While there is insufficient financial data to undertake a similar analysis of regulated Australian utilities, US data provide a strong foundation from which to conclude that the Fama-French three-factor model provides a better estimate of the return on equity for a regulated energy business.

4.1.1 Conclusion

The weight of empirical evidence supports the proposition that the Fama-French three-factor model would be expected to provide a more accurate estimate of the cost of equity for a regulated energy utility than the CAPM. We therefore conclude that the Fama-French three-factor model meets the requirements of Rule 87(1), Rule 74(2)(b) and sections 24(2) and (5) of the NGL.

The discussion above focuses on the empirical evidence as to the accuracy of the Fama-French three-factor model compared to the CAPM, rather than the relative robustness or descriptive accuracy of the two models. In our opinion, this is highly relevant to the question of whether or not the Fama and French selected model is 'well accepted', which we discuss below.

4.2   Is the Fama-French Three-Factor Model Well Accepted?

We concluded in light of the discussion in section 2.1 that the reference in Rule 87 to the use of a 'financial model' concerns the use of a method that may be used to estimate the cost of capital associated with a particular asset. Specifically, such a model would comprise a formula that, when applied to empirical information, would deliver an estimate of the cost of capital.

While there is a specific requirement for the financial model that is used to be 'well accepted', this term does not have a special meaning in economics. However, the characteristics of the estimation of the cost of equity, and the response of the finance profession to those characteristics, provide a guide as why the 'financial model' is required to be 'well accepted' and so what that requirement means in practice.

4.2.1 Characteristics of financial models

The majority of financial models that may be used to estimate the cost of equity commence with a theoretical explanation for the returns that investors should expect from different financial assets,[53] which is then linked to inputs that can be estimated from capital market data. The CAPM and the Fama-French three-factor model both fall within this class of models.[54]

The theoretical derivation of such asset pricing models is typically based on stylised assumptions about such matters as investor preferences and the structural characteristic of capital markets.[55] Such models are understood to be hypotheses rather than completely accurate (or even close to accurate) descriptions of the real world. There is a large array of asset pricing models derived and presented in the finance literature that correspond to different stylised assumptions, with corresponding differing levels of descriptive accuracy. However, the greater descriptive accuracy of an asset pricing model generally brings with it a more complex formula for computing the cost of equity and, most importantly, greater data requirements to apply such a model in practice. Accordingly, the practical application of any asset pricing model inevitably involves a trade-off between descriptive accuracy and the need to obtain robust estimates of the required inputs.

The appropriate test of any asset pricing model is not its descriptive accuracy, but rather its ability to predict accurately the returns that different assets receive. However, tests of the accuracy of asset pricing models are themselves difficult – and the results are often disputed in the empirical finance literature. The main constraint to the test of any asset pricing model is that the model always predicts *expected* (forward-looking) returns, but generally only *realised* returns can be observed. Since realised returns are affected dramatically by random

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[53]   As noted further below, the theoretical models for predicting the return that an investor should require (or expect) from holding an asset simultaneously predict how financial assets should be valued and how investors should structure their portfolios of assets.

[54]   We include the Fama-French three-factor model in the class of Arbitrage Pricing Theory models, which has a rigorous theoretical underpinning.

[55]   For example, the availability of information, size of transactions costs, whether short-selling is allowed and the number of securities on issue and their divisibility.

events, it is difficult to discern the underlying relationships, thereby leaving scope for differing interpretations of the outcomes of tests.

Accordingly, one interpretation of the requirement for a financial model to be 'well accepted' is to stand above individual tests or opinions about the accuracy or otherwise of a particular model, and instead to infer this from an observation of the weight of opinion within the finance profession. In other words, the best interpretation of the well accepted criterion is to judge the merits of the particular financial model by asking whether a sufficient cross-section of participants is convinced of its merits. A requirement to satisfy this criterion would provide confidence that the accuracy of the approach that is used to estimate the cost of equity has been established to a sufficient level and is not based on a potentially artificial relationship that may not be repeated.

In our opinion, the relevant forums – or classes of financial market participant – against which observations of opinion or practice would permit an insight into the merits of a particular model and so conclusions as to the 'well accepted' criterion include:

§   the academic literature;

§   finance market practitioners; and

§   regulators.

Our observations of whether the Fama-French three-factor model is 'well accepted' in these various forums is addressed in turn below. However, two observations are relevant at the outset of this discussion. First, the NGR requires only the relevant financial model to be 'well accepted' – there is no requirement for the model that is used to estimate the cost of equity to be the most 'well accepted' model. Indeed, the fact that the CAPM is provided specifically in the NGR as an *example* of a model that meets this criterion suggests that a number of other models would meet this criterion.

Second, the NGR do not require the model to be unanimously supported in the relevant strand of literature or in the practice of market practitioners that is observed; the NGR require only that it be 'well accepted'. Indeed, the intrinsic nature of discussion of the academic finance literature, the competitive nature of academia and the process by which papers are published – which itself rewards criticism – means that it is unlikely that one will observe a clear consensus.

4.2.2 Acceptance in the academic finance literature

There is a significant body of academic literature that supports the proposition that the Fama-French three-factor model is a reliable predictor of equity returns, and so it is 'well accepted' in that context. These findings include that the results that were first found for a specific time period in the US market have been found also in other major capital markets and at other times in the US. This provides confidence that the factors that are treated as proxies for risk in the Fama-French three-factor model are not statistical artefacts but are true proxies for risk. We note that, in contrast, the empirical support for the CAPM is not strong in the academic literature.

As a reflection of this acceptance, the Fama-French three-factor model is now more widely used as a benchmark by academics than is the CAPM. A search through articles published in the Journal of Finance in 2007, for example, shows that Fama and French's (1993) paper was cited 12 times in articles whereas Sharpe's (1964) paper was cited just once.

Of course, it must also be recognised that the Fama-French three-factor model is subject to criticism in the academic literature, principally on the basis that the identity of the actual factors is not well justified on *a priori* theoretical grounds. This criticism reflects the fact that the specific factors in the Fama-French three-factor model originally were chosen on the basis of empirical observation, rather than from theory, although some theoretical justification for the factors has subsequently been advanced. However, against this we emphasise again that the existence of premiums for the two additional factors is well justified in the empirical literature. As such, the Fama-French three-factor model has a robust theoretical underpinning – the theory is clear that premiums for specific factors *should only be observed systematically* if the relevant factor is a proxy for non-diversifiable risk.

Although we noted above that the 'well accepted' criterion did not require the Fama-French three-factor model to be more widely accepted than the CAPM, since the CAPM is deemed by the NGR to be well accepted, some observations on the CAPM are in order.

§   First, while the CAPM has a robust theoretical underpinning, the 'world' of the CAPM is extremely simplistic and known to be descriptively inaccurate. Indeed, the descriptive inaccuracy leaves a number of unresolvable issues – such as the term of the risk-free rate.

§   Second, we noted above that the empirical evidence in the academic literature is clear that the CAPM provides an incomplete explanation of asset returns and provides less accurate estimates of the cost of equity than models that do take these into account – such as the Fama-French three-factor model.

4.2.3 Acceptance by financial market practitioners

Turning to the potential classes of market participants, it is important to note that the task of allocating capital requires a view to be taken about the factors that explain the expected returns from different financial assets for two logically distinct activities.

§   First, an explicit assumption about the cost of equity is required whenever cash flows are discounted in order to estimate the value of those cash flows. This activity can be further divided into the valuation of a new project and the valuation of an existing firm.

§   Second, the selection of an optimal portfolio of financial assets requires a view on the factors that predict the future returns to different financial assets. Equally, the assessment of the relative performance of a fund manager also requires a view on the factors that systematically affect the returns to different financial assets so that its contribution can be assessed net of this 'expected' component.

Table 4.3 lists the various finance market practitioners and the decisions that they may make that require an assumption about the cost of equity (or, equivalently, the factors that explain the expected return on equity) and the importance of the cost of equity for that decision.

**Table 4.3
Market Practitioners and the Cost of Equity**

	Project Evaluation	Firm Valuation	Portfolio Choice	Fund Evaluation
Managers	High	High	-	-
Equity analysts	-	Low	-	-
Investment banks	High	Low	-	-
Independent experts	-	Low	-	-
Fund managers	-	-	High	-
Asset consultants	-	-	-	High

Our reasons for the views expressed above are as follows.

§ *Project evaluation* – when managers and investment banks evaluate projects, explicit forecasts of cash flow are typically made over an extended period, and so the discount rate adopted can have a profound effect on the estimated value of the project.

§ *Firm valuation* – in our experience, when parties that are outside of the firm seek to value that entity, future cash flow is typically forecast only for a short period of time, with a residual value adopted thereafter. In this case, the forecasts of cash flow and assumed residual value dominate the valuation and the discount rate applied has limited effect. Moreover, explicit assumptions about the cost of equity are only required where the discounted cash flow method is used to value a firm – and this method is actually applied in the minority of cases (the use of the more simplistic approach of applying 'multiples' to current or projected earnings remains the dominant method for valuing firms).

§ *Portfolio choice* – the selection of an optimal portfolio requires an assumption about the different dimensions of risk about which investors should be concerned and a view about the returns that are available for accepting different quantities of those different dimensions of risk. This is discussed further below.

§ *Fund evaluation* – equally, when an asset consultant is assessing the performance of a fund, a view is required to be taken about the returns that a fund manager should be expected to achieve in order for any over- or under-performance to be assessed. In turn, an assessment of the returns that a fund manager would be expected to achieve requires a view to be taken on what variables can predict returns, ie, do equity betas predict returns, or do other factors predict returns?

Accordingly, in our view, the most relevant 'market practice' should be taken as:

§ the practice of managers and investment banks (advisers) when evaluating a new project; and

§ the practice of fund managers and asset consultants when selecting portfolios of financial assets and assessing the contribution of the fund manager, respectively.

The practice of each of these subsets of market participants are discussed in turn.

4.2.3.1. Managers and advisers when assessing a new project

Turning to the assumptions adopted by management, we note that the most recent published survey of the behaviour of Australian managers suggests that none use the Fama-French three-factor model when estimating the cost of equity of their firm or activities.[56] However, an equivalent survey of US managers (CFOs) suggests that a sizeable proportion (over 34 per cent) 'always or almost always' apply the CAPM equation with other risk factors added,[57] and, of this subset, 35 per cent applied a size factor and 12 per cent used a value factor. So, while the use of the Fama-French three-factor model is not widely used for estimating the cost of capital, there is some evidence that it is used by market practitioners for this purpose.

We note that one reason holding back the acceptance of the Fama-French three-factor model by managers and advisors is the availability of factor loadings for the market, *HML* and *SMB* factors. The absence of published factors therefore requires managers to collate detailed market data and then to estimate the required multivariate betas. This contrasts with the CAPM where 'beta books' are readily available for individual firms and different industry groupings. It therefore seems likely that some of the reason for the small inroads that the Fama-French three-factor model has made can be explained by the difficulties that managers and analysts have had in applying the model. The absence of beta books is not a significant issue in a regulatory context given the practice has already evolved towards using more sophisticated techniques for estimating betas.

4.2.3.2. Fund managers and asset allocation consultants

The CAPM and Fama-French three-factor model make different predictions about the investment portfolios that investors will choose. The CAPM predicts that all investors should hold the same portfolio of assets, the market portfolio of all assets.[58] Investors, in the model, attain their desired level of risk by combining a position in the market portfolio with borrowing or lending at the risk-free rate.

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[56] G. Truong, G. Partington, and M. Peat (2005), Cost of capital estimation and capital budgeting practice in Australia, *Working Paper Series*, Finance Discipline, School of Business, University of Sydney.

[57] Graham, J. and C. Harvey, (2001), 'The theory and practice of corporate finance: Evidence from the field', *Journal of Financial Economics*, Vol. 60 (2-3), pp. 187-243.

[58] Although consistent with the findings of Brennan (1970) the inclusion of imputation credits that change the personal tax position of domestic but not international investors, into the CAPM means that domestic shareholders will hold a portfolio weighted towards stocks that distribute credits.

In contrast, in the Fama-French three-factor model, portfolio choice is a more complicated decision and different investors may hold different portfolios. In the Fama-French three-factor model, investors may choose to 'tilt' their portfolios towards or away from the Fama-French factors. That is, some investors may choose to overweight their portfolios with value stocks, while others may choose to overweight their portfolios with growth stocks. Similarly, some investors may choose to overweight their portfolios with small cap stocks, while others may choose to overweight their portfolios with large cap stocks. For example, the proprietor of a small business who is also a large stockholder may choose to hold a portfolio titled towards large growth stocks to hedge the risk the investor faces from fluctuations in the value of the business.

It follows from this practical interpretation of the respective models that, if the CAPM is to be believed, all investors will hold the same portfolio whereas if the Fama-French three-factor model is true, investors may tilt their portfolios. Importantly, a study undertaken by Mercer Investments Nominees[59] of the Australia finds management industry found that there is a 'supply' of portfolios that allow investors to tilt towards or away from the Fama-French factors. The results of the Mercer study are set out in Tables 4.4 and 4.5.

Table 4.4

Quarterly Book to Price Factor Exposures of Australian Shares Equity Managers over the ASX300

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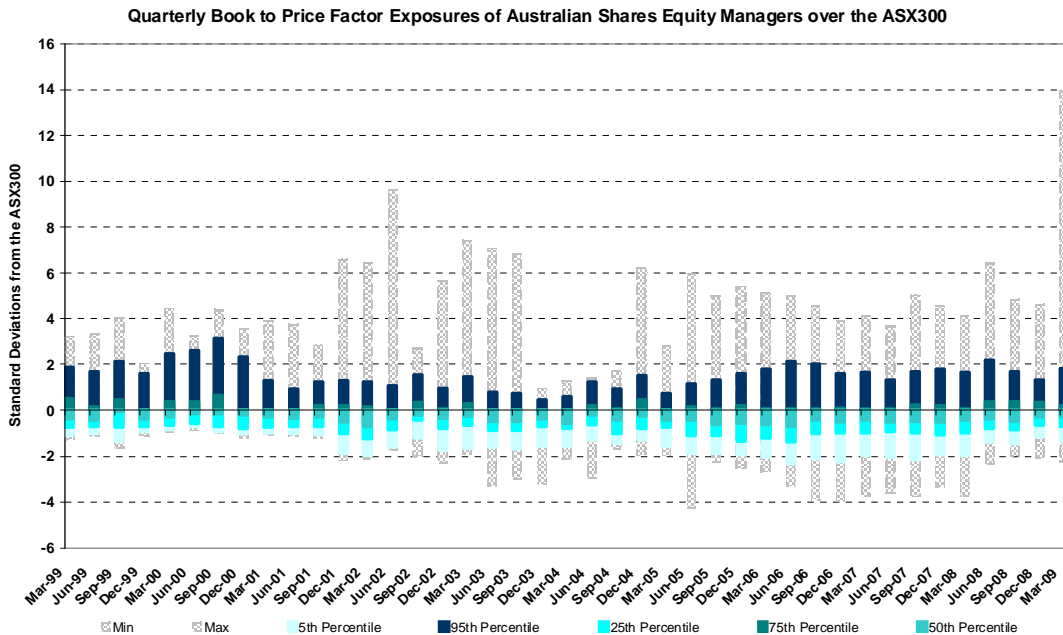
[59] The Mercer review of investment strategies of Australian active managers is provided as Attachment 1 to this report.

Table 4.5

Quarterly Market Cap Factor Exposures of Australian Shares Equity Managers over the ASX300
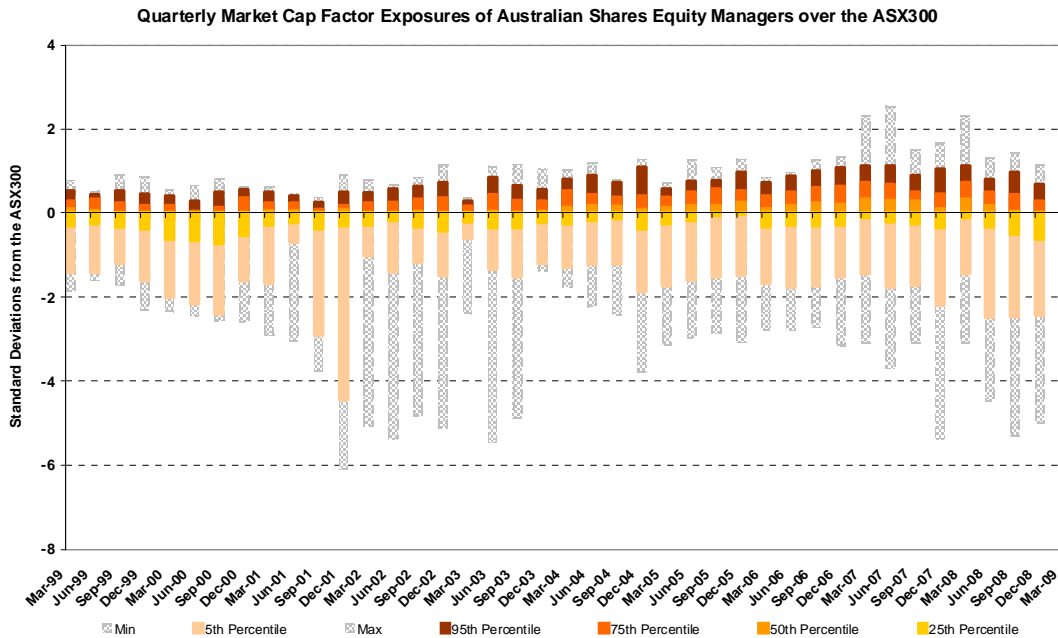
Tables 4.4 and 4.5 show that *on average* the funds monitored by Mercer do not tilt either toward or away from value stocks or small market-cap stocks. This is not surprising since the average investor must hold the market portfolio. However, the Mercer data clearly show that some investors do invest in funds that offer a substantial tilt to some combination of either growth, value, small or large firms.

It is important to note that the Fama-French three-factor model does not suggest that all investors will have tilted portfolios. Rather the existence of a premium for small and value stocks, above and beyond that explained by the CAPM, suggests that these factors are proxies for undiversifiable risks. Investors may wish to tilt in any direction depending on their particular appetite for *HML* or *SMB* risk.

4.2.4 Acceptance by economic regulators

Regulators might be regarded as a further class of financial market 'participants' who need to make a conscious decision as how to estimate the cost of equity. In contrast to financial market participants, regulators do not have a financial interest in the outcome; however, they do have to defend their decisions, and often face the prospect of differing forms of review of their decisions. Accordingly, the decisions of regulators would also provide a check on the accuracy and practicability of a particular financial model.

We are not aware of the Fama-French three-factor model being used by regulators in Australia or overseas. In Australia, we are not aware of it previously having been proposed for use.

We are aware of the Fama-French three-factor model being proposed by T-Mobile for use in estimation of the required return on equity in the UK telecommunications, although it was not adopted by the regulator (Oftel) or at appeal (Competition Commission). T-Mobile was one of five firms that were the subject of the review, the remainder of which proposed using the CAPM. T-Mobile's argument was that the Fama-French three-factor model better fits the empirical data and hence provides a better estimate of the cost of equity. The Competition Commission observed that there were different views amongst academics on the relative merits of the CAPM and Fama-French three-factor model and chose not to apply the latter. However, T-Mobile's proposed cost of capital (24 per cent to 29 per cent) was much higher than the proposals from the other businesses (13 per cent to 18 per cent). In its final analysis,[60] the Competition Commission expressed its estimate of the cost of equity and *WACC* within the structure of the CAPM; however, the range it derived for the cost of equity (7.6 per cent to 12.7 per cent) suggests that its conclusions reflected, in large part, an exercise of judgement rather than the application of particular estimates derived from one model.

In the US, neither the Fama-French three-factor model nor the CAPM is commonly used by regulators to estimate the cost of equity, which reflects the fact that the conditions exist that facilitate application of the dividend growth model. We discuss in Box 4.1 below that the dividend growth model is preferable to both the Fama-French three-factor model and the CAPM, if it can be applied practicably. Accordingly, in our opinion US practice does not provide any practicable guidance as to what should be applied in Australia.

**Box 4.1
Dividend Growth Model**

> The dividend growth model,[61] or the discounted cash flow model as it is often referred to in the US, involves the analyst forecasting the future distributions that investors expect to receive for a particular equity, and then calculating the cost of equity as the discount rate that reconciles the observed price for the share with those forecast distributions.[62] The strength of the dividend growth model is that it makes very few assumptions about investor preferences or the structural characteristics of markets – the only assumptions required are that the value of an asset reflects its discounted payoffs, that assets are fairly priced and that the analyst's forecast of future distributions is unbiased.
>
> The constraint to using the dividend growth model is whether a practicable means of obtaining a forecast of future dividends from a particular company exists. When the method is applied in the US, the forecast of future dividends is normally taken as an average of equity analysts' forecasts of growth in dividends. Application of this method, in turn, requires a deep pool of analysts' forecasts of dividend growth for the relevant firms over the medium term, which exists in the US but does not exist at present in Australia. Accordingly, this model is not considered further in this report.

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[60]   Competition Commission (2003), *Vodafone, O2, Orange and T-Mobile*, paras 7.251-7.265.

[61]   Gordon is credited with this method for estimating the cost of equity (Myron J. Gordon (1962), *The Investment, Financing and Valuation of the Corporation*, Homewood Ill., R.D. Irwin).

[62]   Adjustments are also required for other factors that may affect expected future distributions, such as the effect of new share issues.

In a recent study of the cost of capital methodology sponsored by the New Zealand Commerce Commission, two high-profile academics from the US and UK, Professors Myers of MIT and Professor Franks of the London Business School, recommended that they 'are in favour of employing the DCF and Fama-French three-factor models as cross-checks on CAPM estimates of the cost of capital.'[63] Out of three academics making recommendations on the desirability and applicability of the Fama-French three-factor model for regulatory purposes, these two academics supported its use. The New Zealand Commerce Commission has recently released its *Revised Draft Guidelines* on its approach to estimating the cost of capital. These guidelines recommend retention of the CAPM as the primary tool for estimating the cost of capital, but also recommend that the Commission 'may use evidence based on the Fama-French and DCF models as cross-checks on the CAPM'.[64]

4.3 Estimates or Forecasts 'on a Reasonable Basis'

We noted above that Rule 74(2) of the NGR requires that any estimate or forecast be 'arrived at on a reasonable basis'. In our opinion, the use of the Fama-French method is a reasonable basis for estimating the cost of equity for the following reasons.

- First, compared to the alternative – the CAPM – the weight of evidence supports the proposition that the Fama-French three-factor model provides a more accurate estimate of the cost of equity. This evidence includes evidence at the market level (that is, tests of the accuracy of the model for generic portfolios of assets) and specifically in relation to energy utility firms.

- Second, as discussed above, the Fama-French three-factor model is well accepted by finance market participants, particularly in finance academia but also to an observable extent by finance market practitioners.

- Third, as a consequence of the first of these points, the Fama-French three-factor model should require less judgement by the AER when estimating the cost of equity, thereby reducing the extent of disputes between the regulator and regulated entities and improving the degree of certainty.

The following section reports our estimates of the required return on equity using a domestic version of the Fama-French three-factor model.

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[63] Julian Franks, Martin Lally and Stewart Myers (2008), *Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital Methodology*,. Report to the New Zealand Commerce Commission, p.8.

[64] Commerce Commission (2009), *Revised Draft Guidelines: The Commerce Commission's Approach to Estimating the Cost of Capital,* 19, June, p. 21.

5.   Cost of Equity - Fama-French Three-Factor Model

We have used the Fama-French three-factor model to estimate the cost of equity for an Australian gas distributor. Where appropriate, we have adopted the same data and parameters as those the AER used in its recent review of the *WACC* parameters for electricity lines businesses, specifically:

§   a 10-year Commonwealth bond yield as the proxy for the risk-free rate;

§   a market risk premium of 6.5 per cent;

§   the same set of comparable Australian companies;

§   weekly and monthly data; and

§   an estimation period from 1 January 2002 to present.

For those parameters not shared with the CAPM, we have primarily used data provided by DFA, an investment group affiliated with Fama and French that explicitly invests along lines suggested by the Fama-French model. DFA data were used to calculate the:

§   Australian *HML* risk premium; and

§   Australian *SMB* risk premium.

Using these data to estimate the parameters of a domestic version of the Fama-French three-factor model results in a return on equity of 11.57 per cent or 6.46 percentage points above the risk-free rate.

To calculate the cost of equity using the Fama-French three-factor model requires estimates of:

§   the three risk premiums, ie:

  –   the market risk premium;

  –   the *HML* risk premium; and

  –   the *SMB* risk premium;

§   the three multivariate betas, ie:

  –   the market beta;

  –   the *HML* beta; and

  –   the *SMB* beta.

We describe below the approach we have taken to estimating each of these parameters.

5.1   Risk Premiums

The Fama-French three-factor model assumes that an asset's mean return is explained by the covariance of the return with the following three factors:

§   the difference between the return on the market portfolio and the risk-free rate;

§   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

§   the difference between the return to a portfolio of small cap stocks and the return to a portfolio of large cap stocks (*SMB*).

The premium for bearing each risk is the mean value of each factor. The mean difference between the return to the market portfolio and the risk-free rate is the market risk premium (*MRP*), a parameter that is common to both the CAPM and the Fama-French three-factor model. The AER has recently considered what value the domestic *MRP* should take on in its review of the *WACC* parameters for electricity lines businesses. After considering a range of estimates for the *MRP* the AER determined that the best estimate of the current forward looking domestic market risk premium is 6.5 per cent per annum.[65] This estimate includes an amount that recognises the value of franking credits to the investor. For the purpose of this analysis we have adopted the AER's estimate of the *MRP*.

Unlike the *MRP*, the *HML* and *SMB* risk premiums are not required by the CAPM and so estimates of the premiums have not previously been considered by the AER. We have examined a range of data sources that one might use to estimate the *HML* and *SMB* premiums. Appendix A describes the data provided by our preferred source, Dimensional Fund Advisors Australia Ltd (DFA), a company with whom Professors Fama and French are affiliated. We find that the DFA *HML* premium is economically and statistically significantly different from zero. The DFA *SMB* premium, on the other hand, is neither economically nor statistically different from zero.

We have also computed *HML* and *SMB* risk premiums using Morgan Stanley Capital International (MSCI) data (see Appendix B). The MSCI *HML* and *SMB* premiums are both economically significant, but neither premium is statistically significantly different from zero. We have found, however, that Fama-French three-factor model estimates of the return on equity for a gas distribution business computed from the MSCI data are similar to those computed from the DFA data.

Using the raw data provided by DFA we have carried out the following steps to estimate the *HML* and *SMB* risk premiums.

§   First, we have calculated the arithmetic average of the differences between the annual returns to a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. Similarly, we have calculated the arithmetic average of the differences between the annual returns to a portfolio of small cap stocks and a portfolio of large cap stocks.

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[65]   AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 236.

§   Second, we have adjusted these averages to reflect an assumption that investors place a positive value on distributed franking credits.

Thus the *HML* and *SMB* risk premiums that we use are the historical averages of the imputation credit-adjusted annual returns to the *HML* and *SMB* zero-investment portfolios created by DFA. The use of arithmetic averages of historical annual returns is consistent with the approach adopted by Handley (2009) in his report to the AER on the *WACC* parameters of electricity lines businesses.[66]

To determine the maximum quantity of franking credits that can be attached to the dividends that each portfolio pays out each year, we use the statutory corporate tax rates in effect at the time. To compute the quantity of franking credits distributed, we follow Handley and Maheswaran (2008) and assume that 75 percent of dividends are franked.[67] Finally, to compute the value the market places on these franking credits, we have been instructed by JGN to assume that the market places a value of 20 cents on a dollar of franking credits distributed.

Thus, for example, in 2008 the statutory corporate tax rate was 30 percent and so 43 cents of franking credits would have been attached to a fully franked dividend of one dollar in that year. If 75 percent of 2008 dividends were franked, on average 32 cents of franking credits would have been attached to a dividend of one dollar. Finally, if the market placed a value of 20 cents on a dollar of franking credits distributed, the market would have placed a value of 6 cents on the franking credits attached on average to a 2008 dividend of one dollar.

In 2008, the dividend yields on the value and growth portfolios were 7.38 and 4.44 percent, measured as the sum of the dividends paid out over the year divided by end-of-year price. So we assume that the credits attached to the dividends paid out by the value and growth portfolios were $0.43 \times 0.75 \times 7.38 = 2.37$ percent and $0.43 \times 0.75 \times 4.44 = 1.43$ percent of the end-of-year price. The *HML* factor, exclusive of franking credits, in 2008 was – 3.33 percent. It follows that, with the assumptions we make, the factor inclusive of the value of franking credits was $– 3.33 + 0.2 \times (2.37 – 1.43) = – 3.14$.

Table 5.1 below shows estimates of the *HML* and *SMB* premiums computed using the data supplied to us by DFA. The time period of 1975 to 2008 is the longest period over which data on the Fama-French factors are available in Australia. The *HML* estimate is significantly greater than zero at conventional levels and of the same order of magnitude as the market risk premium. The *SMB* estimate is negative, although not significantly different from zero.

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[66]   John C Handley, Further Comments on the Historical Equity Premium: Report for the Australian Energy Regulator, 14 April 2009, pages 4-6.

[67]   Handley J. and Maheswaran K., A Measure of the Efficacy of the Australian Imputation Tax System, *The Economic Record*, Vol 84 No 264, March 2008, page 91.

Table 5.1
Fama-French Risk Premiums

	Market Risk Premium	*HML* Risk Premium	*SMB* Risk Premium
Australia	6.50	6.24	−1.23
		(3.07)	(2.24)
Period		1975 – 2008	1980 – 2008
US		6.00	1.18
		(2.52)	(2.03)
Period		1975 – 2008	1980 – 2008
US		5.26	3.53
		(1.55)	(1.58)
Period		1926 – 2008	1926 – 2008

Premium estimates in percent per annum are outside of parentheses. Standard errors are in parentheses

For comparison, we also report US estimates computed with data taken from Ken French's web site over the same periods that we use to estimate the Australian premiums, as well as over the period from 1926 through 2008, the longest period over which data on the Fama-French factors are available in the US. The US *HML* and *SMB* estimates are similar to their Australian counterparts over matching periods. On the other hand, the US *HML* estimate computed over the longer period, is lower than its Australian counterpart while the US *SMB* estimate computed over the longer period is substantially higher than its Australian counterpart. The US *SMB* estimate computed over the longer period is both economically and statistically significantly different from zero.

In principle, the method of Anderson (1957) can be used to combine the Australian and US data so as to produce more efficient estimates of the Australian *HML* and *SMB* premiums.[68] However, our analysis shows that there is little to be gained from using the method. The relations between the Australian and US *HML* and *SMB* series are sufficiently weak that the standard errors of the premium estimates barely fall.

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[68] Anderson, T.W., Maximum Likelihood Estimates for a Multivariate Normal Distribution When Some Observations Are Missing, *Journal of the American Statistical Association*, June 1957.

5.2   Beta Estimates

We have computed beta estimates for the nine individual securities and for two portfolios of the securities, one equally weighted and the other value-weighted, using weekly and monthly data. To compute the estimates, we regressed the returns on the nine utilities on the market return and the *HML* and *SMB* factors.

It is important to note that the beta or exposure of a stock relative to the market in the Fama-French three-factor model need not be the same quantity as the beta of the stock relative to the market in the CAPM. The Fama-French beta is the slope coefficient on the market return (or the market excess return) from a *multivariate* regression of the return to the stock on the three Fama-French factors. The CAPM beta is the slope coefficient from a *univariate* regression of the return to the stock on the market return (or the market excess return).[69] Thus in general it would be wrong to use the *multivariate* estimates that we report together with the CAPM to determine the return required on the equity of a gas utility.

Table 5.2 shows that none of the nine utilities has a debt-to-value ratio of 0.6, ie, the ratio that the AER assumes a benchmark utility should have. We have therefore adjusted (relevered) all of our beta estimates to reflect this benchmark assumption. More specifically, we have followed Henry (2009) and multiplied each return by $(1 - L_j)/(1 - 0.6)$, where L_j is the average net debt-to-value ratio over the period for which net debt and market capitalisation data are available for the utility.[70] If the utility follows a strategy of issuing or retiring debt to ensure its leverage is constant through time, then relevering in this way is appropriate.

Tables 5.2 through 5.4 show our estimates of the betas of the nine utilities relative to the three Fama-French factors. We have computed these estimates in two ways. First, we have computed ordinary least squares (OLS) estimates and, second, we have computed least absolute deviations (LAD) estimates. LAD estimates can be more efficient if a sufficient number of outliers are present. We have computed LAD estimates using the LAV routine in SAS/IML. This routine uses the algorithm that Madsen and Nielsen (1993) introduced and computes standard errors using the approximation suggested by McKean-Schrader (1987).[71]

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[69]   A univariate regression seeks to explain variation in one variable, the dependent variable, by variation in one other variable, the 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.

[70]   Olan T. Henry, Estimating *b*: Report for the Australian Energy Regulator, 23 April 2009, page 9.

[71]   Madsen, K., H.B. Nielsen, A Finite Smoothing Algorithm for Linear l_1 Estimation, *SIAM J. on Optimization* 3, 1993, pages 223-235.

McKean, J.W., and R.M. Schrader, Least Absolute Errors Analysis of Variance, in *Statistical Data Analysis Based on the L_1-Norm and Related Methods* (edited by Yadolah Dodge), North-Holland, Amsterdam, 1987, pages 297-305.

Table 5.2
Individual security market beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	1.24	0.70	0.65	0.33	0.36	0.39	1.71	0.60	0.18
	(0.23)	(0.19)	(0.08)	(0.06)	(0.05)	(0.10)	(0.23)	(0.16)	(0.09)
LAD	0.73	0.74	0.67	0.24	0.28	0.34	0.98	0.48	0.16
	(0.22)	(0.19)	(0.09)	(0.07)	(0.03)	(0.11)	(0.12)	(0.14)	(0.06)
					Monthly data				
OLS	1.05	0.83	0.77	0.37	0.48	0.60	-0.34	0.51	0.11
	(0.51)	(0.35)	(0.20)	(0.16)	(0.15)	(0.21)	(0.86)	(0.30)	(0.23)
LAD	1.17	0.61	0.94	0.40	0.45	0.41	0.99	0.44	-0.10
	(0.52)	(0.53)	(0.17)	(0.15)	(0.11)	(0.20)	(0.39)	(0.30)	(0.31)

Standard errors are in parentheses.

Table 5.3
Individual security *HML* beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	0.33	-0.30	0.22	0.18	0.45	0.06	2.69	0.63	0.40
	(0.45)	(0.36)	(0.13)	(0.10)	(0.08)	(0.19)	(0.36)	(0.24)	(0.14)
LAD	-0.06	-0.03	0.28	0.16	0.24	0.27	1.23	0.49	0.27
	(0.43)	(0.35)	(0.15)	(0.10)	(0.05)	(0.21)	(0.18)	(0.21)	(0.10)
					Monthly data				
OLS	1.14	1.26	0.10	0.10	0.87	1.12	0.60	-0.28	-0.04
	(0.98)	(0.69)	(0.37)	(0.27)	(0.27)	(0.41)	(1.34)	(0.44)	(0.33)
LAD	0.66	0.85	0.00	0.34	0.89	0.90	1.56	-0.64	0.38
	(1.00)	(1.04)	(0.30)	(0.24)	(0.20)	(0.38)	(0.62)	(0.44)	(0.45)

Standard errors are in parentheses.

Table 5.4
Individual security *SMB* beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	0.36	0.13	0.33	0.29	0.46	0.19	1.02	0.48	-0.01
	(0.32)	(0.25)	(0.14)	(0.11)	(0.08)	(0.13)	(0.41)	(0.28)	(0.17)
LAD	0.37	0.50	0.46	0.37	0.25	0.32	0.44	0.23	0.31
	(0.30)	(0.24)	(0.15)	(0.11)	(0.05)	(0.14)	(0.20)	(0.25)	(0.11)
					Monthly data				
OLS	0.75	-0.70	-0.13	0.25	0.18	0.33	2.32	-0.18	-0.05
	(0.62)	(0.42)	(0.28)	(0.23)	(0.20)	(0.25)	(1.16)	(0.38)	(0.31)
LAD	0.44	-1.01	-0.39	0.38	0.14	0.24	0.58	-0.32	0.34
	(0.64)	(0.63)	(0.23)	(0.20)	(0.15)	(0.23)	(0.54)	(0.38)	(0.42)

Standard errors are in parentheses.

Tables 5.2 through 5.4 show that many of the individual security estimates of betas are imprecise. The tables also show that estimates of the *HML* and *SMB* betas tend to be less precise than their market counterparts. The reason for this difference is that the precision with which a slope coefficient in a regression is estimated is typically inversely related to the volatility of the corresponding regressor and the *HML* and *SMB* factors are less volatile than the market return. Finally, the table shows that estimates of the betas computed using monthly data are less precise than estimates computed using weekly data. The standard errors attached to the monthly estimates are approximately twice as large as the standard errors attached to the weekly estimates.

Myers (2008) recommends that[72]

> 'when a sample of similar companies can be identified, industry betas should be estimated, as this will significantly improve the statistical reliability (lower the standard errors) of the estimates.'

We have combined the individual security data in three ways. First, we have computed simple averages of the security beta estimates. Second, we have formed an equally weighted portfolio of the nine securities and have estimated its beta. Since six of the nine utilities either listed or delisted over the sample period, there are often fewer than nine utilities in the portfolio. When a new firm is listed we sell some of what we have invested in the other listed securities and invest the proceeds in the newly listed entity. When a firm delists, we sell the

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[72] Franks, J, M. Lally, S. Myers, Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital, 18 December 2008.

security and invest the proceeds in the remaining listed securities. Third, we have formed a value-weighted portfolio and have estimated its beta.

Myers (2008) recommends that[73]

> 'industry betas should be estimated using returns on a portfolio of the sample companies, *not* solely as an average of individual company betas as the (New Zealand Commerce) Commission presently does. This approach is desirable because the standard error of the industry estimate is readily obtained.'

If no firms list or delist during the sample period, then the average of the ordinary least squares (OLS) security beta estimates will be identical to the OLS estimate of the beta of an equally weighted portfolio. If some firms list or delist during the sample period, however, the two estimates will generally differ. Myers emphasises that 'the standard error of the industry estimate is readily obtained' because computing the standard error of the portfolio estimator is straightforward whereas computing the standard error of the average estimator is a more complicated task when some data are missing. Put another way, Myers is advocating that portfolio estimates be used because they are more efficient than individual security estimates and because their standard errors are readily obtained when some of the securities list or delist in the sample period.

Besides the ease with which their standard errors are computed, though, portfolio estimates may be more efficient. A simple average of security beta estimates places an equal weight on each estimate. In other words, a simple average places as much weight on estimates computed from a few observations as on estimates computed from many observations. A portfolio estimate effectively places a greater weight on securities for which more observations are available and so for which more information is available.

We have computed portfolio beta estimates in two ways. First, we have computed estimates for an equally weighted portfolio. Second, we have computed estimates for a value-weighted portfolio. A rationale for using a value-weighted portfolio is that it is likely that value-weighted estimates are less sensitive to merger and breakup activity than equally weighted estimates – at least if the market correctly prices assets. Suppose, for example, there are two companies in the industry one examines of equal size and one company breaks up into nine new companies. A value-weighted portfolio would continue to invest half of its assets in the nine new companies whereas an equally weighted portfolio would sell 80 percent of its investment in the company that had not been broken up and would raise its stake in the nine new companies from 50 to 90 percent. The value-weighted portfolio would continue to hold the same portfolio of underlying projects as before whereas the equally weighted portfolio would not continue to hold the same portfolio.

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[73] Franks, J, M. Lally, S. Myers, Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital, 18 December 2008.

Henry (2009), on the other hand, states that:[74]

> Technically, a portfolio is defined using a fixed vector of weights. If the vector of weights changes a new portfolio is defined. Moreover, when a new business "drops in" and/or "drops out" of the portfolio, both the investment opportunity set and/or the market portfolio may change as a result of takeovers and IPO activity. In short, great caution should be exercised when interpreting the β estimates from the resulting 'portfolios'.

However, a portfolio that invests solely in a single stock will not control the same set of physical assets over time (even though the stock portfolio is unchanged). This is because companies typically invest in new projects and let old projects die as time passes.

Table 5.5 displays our average and portfolio estimates. Five observations may be drawn from the results in Table 5.5:

§ the evidence indicates that the returns to utility stocks are related to all three Fama-French factors – in fact, the beta of a utility stock relative to the *HML* factor is about as large as the beta of the stock relative to the market;[75]

§ the standard errors of the average and portfolio estimates are typically lower than their individual security counterparts, and so the average and portfolio estimates are more precise than the individual security estimates;

§ there is, partly as a result, for each parameter, less variation in the portfolio estimates across the different estimation methods than in the individual security estimates across the different methods;

§ as before, the weekly estimates are more precise than their monthly counterparts; and

§ consistent with our discussion above, the standard errors attached to the average of the OLS estimates for individual firms are higher than their equally weighted portfolio counterparts, although not dramatically so.

In weekly data there is almost no difference between the standard errors of the LAD estimates and the standard errors of the OLS estimates. In monthly data, there are differences but the differences do not appear to be systematically positive or negative. We do not report the standard errors attached to the average of the LAD estimates for the individual securities as computing these standard errors is a complicated task when data are missing. We are not aware of an analytical formula for the standard error of the average of the LAD estimates when data are missing. Computing the standard error of the average by simulation would require we make an assumption about the distribution of returns and the incidence of outliers.

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[74] Olan T. Henry, Estimating *b*: Report for the Australian Energy Regulator, 23 April 2009, page 25.

[75] Again, note that the Fama-French beta relative to the market is the slope coefficient from a multivariate regression. In contrast, the beta relative to the market of the CAPM is the slope coefficient from a univariate regression. Thus the two quantities can differ.

Table 5.5
Average and portfolio beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	Market			HML			SMB		
	AV	EW	VW	AV	EW	VW	AV	EW	VW
	Weekly data								
OLS	0.69	0.66	0.57	0.52	0.71	0.43	0.36	0.41	0.23
	(0.06)	(0.05)	(0.06)	(0.10)	(0.08)	(0.10)	(0.10)	(0.08)	(0.10)
LAD	0.52	0.49	0.62	0.32	0.53	0.36	0.36	0.28	0.17
		(0.05)	(0.06)		(0.08)	(0.09)		(0.08)	(0.10)
	Monthly data								
OLS	0.49	0.46	0.68	0.54	0.40	0.47	0.31	0.29	-0.14
	(0.16)	(0.14)	(0.15)	(0.27)	(0.26)	(0.27)	(0.21)	(0.19)	(0.19)
LAD	0.59	0.65	0.69	0.55	0.63	0.30	0.04	-0.05	-0.28
		(0.12)	(0.21)		(0.22)	(0.37)		(0.16)	(0.27)

Standard errors are in parentheses.

In the absence of missing data, the average OLS estimate will be identical to the OLS estimate of the beta of an equally weighted portfolio. On the other hand, it is not in general true that the average LAD estimate will match the LAD estimate of the beta of an equally weighted portfolio, even in the absence of missing data. The question then arises as to whether it is better to use the average LAD estimate or the LAD estimate of the beta of an equally weighted portfolio or whether it is not possible to conclude without further information. To investigate the behaviour of the average LAD estimator, the LAD estimator for an equally weighted portfolio and the OLS estimator for the portfolio, we have conducted simulations.

5.2.1 Simulations

The simulations are designed to discover whether there are circumstances where one estimator is more efficient than the others. While the parameters we have chosen are meant to reflect the behaviour of the weekly data we have, we have not gone so far as to try and use our data to calibrate the simulations. In other words, we have chosen parameters that are similar to but not identical to the parameters one might choose if one were to calibrate the simulations to the data. Since the simulations examine the behaviour of outliers and there are few of these, calibrating the simulations to our data would not be a simple task. The simulations show that there are circumstances where the average LAD estimator is most efficient, there are other circumstances where the portfolio LAD estimator is most efficient and there are yet another set of circumstances where the portfolio OLS estimator is most efficient.

Following Dielman (1986) we generated outliers by mixing normal distributions.[76] We generated 400 returns for 10 securities. In particular, we generated the return to security j as

$$R_j = b_j\,R_m + h_j\,HML + s_j\,SMB + e_j + h_i + z_j, \qquad j = 1, 2, ..., 10,$$

where

R_m, *HML* and *SMB* are normally and independently distributed each with mean zero and standard deviation 0.02; and

the disturbance $\varepsilon_j + \eta_i + \zeta_j$ is the sum of three random variables:[77]

(i)   a firm-specific random variable ε_j that is normally distributed with mean zero and standard deviation 0.04,

(ii)   an industry-outlier random variable η_i that with probability 0.9 takes on the value zero and with probability 0.1 is a draw from a normal distribution that has a mean of zero and standard deviation of $0.04 \times \theta$, and

(iii)   a firm-outlier random ζ_j variable that with probability 0.9 takes on the value zero and with probability 0.1 is a draw from a normal distribution that has a mean of zero and standard deviation of $0.04 \times \varphi$.

The random variables R_m, *HML*, *SMB*, e_1, e_2, ..., e_{10}, η_i, ζ_1, ζ_2, ..., and ζ_{10}, are normally and independently distributed. We assume that there are no missing data. Thus the average OLS estimator of a beta and the OLS estimator of the beta for an equally weighted portfolio will be identical.

The parameters θ and φ determine the extent to which outliers are the result of industry-wide events or firm-specific events. All else constant, the higher is θ (φ), the more likely are outliers to result from an industry-wide (firm-specific) event.

We examined the behaviour of the average LAD estimator of h_j, the portfolio LAD estimator of h_j and the portfolio OLS estimator of h_j across 25 combinations of θ and φ. For each combination, we conducted 2,500 replications. Tables 5.6 and 5.7 show the results of our simulations.

Table 5.6 displays the relative efficiency of the average LAD estimator with respect to the portfolio LAD estimator as a function of θ and φ. The average LAD estimator is the equally weighted average of the security-level estimators while the portfolio LAD estimator is the single estimator computed using the equally weighted return to a portfolio of the securities. The relative efficiency of the average LAD estimator with respect to the portfolio LAD estimator is the ratio of the variance of the portfolio LAD estimator to the variance of the

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[76]   Dielman, T., A Comparison of Forecasts from Least Absolute Value and Least Squares Regression, *Journal of Forecasting* 5, 1986, pages 189-195.

[77]   The standard deviations have not been calibrated for actual data due to insufficient outlier data. The purpose of the standard deviations is to illustrate when difference statistical procedures provide best estimators.

average LAD estimator. Thus if the ratio exceeds (falls below) one, the average (portfolio) LAD estimator is deemed to be more efficient than the portfolio (average) estimator.

Table 5.6 indicates that when θ is high relative to φ, the portfolio LAD estimator is more efficient than the average LAD estimator. On the other hand, when φ is high relative to θ, the average LAD estimator is more efficient than the portfolio LAD estimator. In other words, the results suggest that if there are large industry-wide outliers it is better to use LAD to deal with the outliers at the portfolio level while, if there are large firm-specific outliers, it is better to use LAD to deal with the outliers at the firm level.

Table 5.6
Relative efficiency of the average LAD estimator with
respect to the portfolio LAD estimator

θ	Φ				
	0	1	2	3	4
0	1.012	1.069	1.199	1.489	1.669
1	0.828	0.986	1.063	1.245	1.495
2	0.704	0.744	0.876	1.023	1.218
3	0.634	0.673	0.812	0.931	1.048
4	0.632	0.647	0.730	0.882	1.106

The standard deviation of firm outliers rises as φ increases while the standard deviation of industry outliers rises as θ increases.

Table 5.7 displays the relative efficiency of the average LAD estimator with respect to the portfolio OLS estimator as a function of θ and φ. If the ratio exceeds (falls below) one, the LAD (OLS) estimator is deemed to be more efficient than the OLS (LAD) estimator.

Table 5.7 indicates that when θ and φ are low, the OLS estimator is more efficient than the average LAD estimator. This result is consistent with what Dielman (1986) documents and is, of course, consistent with theory since when $\theta = \varphi = 0$, the OLS estimator is the maximum likelihood estimator.[78] On the other hand, when θ and φ are high, there is a considerable advantage to using the LAD estimator. This result is also consistent with what Dielman finds.

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[78] Dielman, T., A Comparison of Forecasts from Least Absolute Value and Least Squares Regression, *Journal of Forecasting* 5, 1986, pages 189-195.

Table 5.7
Relative efficiency of the average LAD estimator with
respect to the portfolio OLS estimator

θ	Φ				
	0	1	2	3	4
0	0.627	0.671	0.794	1.088	1.356
1	0.901	1.050	1.048	1.169	1.548
2	1.884	1.776	1.819	1.927	2.153
3	3.314	3.054	3.181	3.294	3.383
4	5.103	4.962	4.956	5.549	5.408

*The standard deviation of firm outliers rises as φ increases while the standard deviation of industry outliers
rises as θ increases.*

To summarise, our simulations show that there are circumstances where the average LAD
estimator is most efficient, there are other circumstances where the portfolio LAD estimator
is most efficient, and there are yet another set of circumstances where the portfolio OLS
estimator is most efficient. Since trying to identify which set of circumstances are best
described by our data is difficult, we suggest that values for the three betas be chosen by
examining all of the average and portfolio estimates that we have produced with weekly data.

We recommend the use of weekly data because these give rise to more precise estimates than
can be produced with monthly data. Similarly, we recommend the use of average or portfolio
estimates because they tend to be more precise than individual firm estimates. Finally, we
recommend that one examine all average and portfolio LAD and OLS estimates.

5.3 Conclusion

Table 5.8 shows the average and portfolio beta estimates that we have produced using the Fama-French three-factor model and the data supplied by Dimensional Fund Advisors Australia Ltd. For the reasons set out in section 5.2.1, we recommend that, when estimating the return required on an Australian regulated energy utility using a domestic version of the Fama-French three-factor model, one should employ:

§   weekly data, since employing weekly data provides more precise estimates than employing monthly data; and

§   all average and portfolio LAD and OLS estimates.

Accordingly, in our opinion the mean of the six weekly beta estimates best considers all available market data and should be used to populate a domestic version of the Fama-French three-factor model.

Using means of the weekly DFA beta estimates as set out in Table 5.8 and the risk premiums set out in Table 5.1, the preferred parameters of a domestic version of the Fama-French three-factor the cost of equity for a gas distribution business are as follows:

$$\mathrm{E}(R_e) = R_f + b_e MRP + h_e HMLP + s_e SMBP,$$

where

R_f is the risk-free rate, which was 5.1123% for the 20 days up to and including the 29 May 2009;[79]

b_e is the market beta of 0.59;

h_e is *HML* beta of 0.48;

s_e is *SMB* beta of 0.30;

MRP   is the market risk premium of 6.50 per cent;

HMLP is the *HML* risk premium of 6.24 per cent; and

SMBP is the *SMB* risk premium of -1.23 per cent.

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[79]   Note that the sample period used in section 5.3 to estimate the risk-free rate is only indicative and that a different sample period may result in a different return on equity. Our analysis of the domestic Fama-French three-factor model suggests that the return on equity for a gas distribution business is 6.46 percentage points above the risk-free rate.

Table 5.8
Fama-French Three-factor Model
DFA Data

		Market Beta	*HML* Beta	*SMB* Beta	Risk Premium
	Weekly Data				
OLS	Equally Weighted Portfolio	0.66	0.71	0.41	8.21
	Value-Weighted Portfolio	0.57	0.43	0.23	6.10
	Firm Average	0.69	0.52	0.36	7.28
LAD	Equally Weighted Portfolio	0.49	0.53	0.28	6.15
	Value-Weighted Portfolio	0.62	0.36	0.17	6.07
	Firm Average	0.52	0.32	0.36	4.93
	Mean Weekly Value	**0.59**	**0.48**	**0.30**	**6.46**
	Monthly Data				
OLS	Equally Weighted Portfolio	0.46	0.40	0.29	5.13
	Value-Weighted Portfolio	0.68	0.47	-0.14	7.52
	Firm Average	0.49	0.54	0.31	6.17
LAD	Equally Weighted Portfolio	0.65	0.63	-0.05	8.21
	Value-Weighted Portfolio	0.69	0.30	-0.28	6.70
	Firm Average	0.59	0.55	0.04	7.22
	Mean Monthly Value	**0.59**	**0.48**	**0.03**	**6.83**

Applying these parameter values to a domestic version of the Fama-French three-factor model results in a post-tax cost of equity of 11.57 per cent for a gas distribution business, ie:

$$11.57\% = 5.11 + 0.59 \times 6.50\% + 0.48 \times 6.24\% + 0.30 \times -1.23\%$$

We note that, if preference were to be given to the use of monthly rather than weekly data, this would suggest a post-tax cost of equity greater than 11.57 per cent.

Appendix A. Data Sources for the Fama-French Three-Factor Model

The domestic Fama-French three-factor model relies on the following three categories of data to estimate the return on equity for gas distribution businesses:

§ a risk-free rate;

§ the returns of a comparable group of Australian regulated energy businesses; and

§ the three Fama-French factors.

Each of these data categories is discussed in turn.

A.1. Risk-Free Rate

The risk-free rate is the rate of return that investors earn from holding an asset with a guaranteed return. Current regulatory practice is to use an annualised yield on ten-year Government bonds as the proxy for the risk-free rate.[80]

The AER state that the ten-year Government bond yield:[81]

> is appropriate having regard to the economic costs and risks of the potential framework in under and over investment

For the proposes of this analysis we use the arithmetic average of the annualised yield of ten-year Government bonds over the 20 days up to and including the 29 May 2009. We note that the sample period is indicative and that a different sample period may result in a different return on equity. Table A.1 sets out the interpolated ten-year yields on Commonwealth Government bonds as published by the Reserve Bank of Australia.

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[80] AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, pages 171-175.

[81] AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 174.

**Table A.1
Risk-Free Rate**

Date	Yield	Annualised Yield
4-May-2009	4.72%	4.78%
5-May-2009	4.84%	4.90%
6-May-2009	4.80%	4.86%
7-May-2009	4.92%	4.98%
8-May-2009	4.99%	5.05%
11-May-2009	4.95%	5.01%
12-May-2009	4.96%	5.02%
13-May-2009	4.95%	5.01%
14-May-2009	4.90%	4.96%
15-May-2009	4.89%	4.95%
18-May-2009	4.88%	4.94%
19-May-2009	5.02%	5.08%
20-May-2009	5.10%	5.17%
21-May-2009	5.14%	5.21%
22-May-2009	5.23%	5.30%
25-May-2009	5.30%	5.37%
26-May-2009	5.26%	5.33%
27-May-2009	5.42%	5.49%
28-May-2009	5.39%	5.46%
29-May-2009	5.31%	5.38%
Average	**5.05%**	**5.11%**

A.2. Australian Regulated Energy Businesses

Weekly and monthly with-dividend returns have been calculated for the nine Australian regulated businesses that the AER examined in its review of the *WACC* parameters for electricity lines businesses.[82]   The nine businesses, their tickers and the period over which returns are available for each company appear in Table A.1.

We note that electricity businesses are a close but not perfect comparator to a gas distribution business. Furthermore, the inclusion of electricity gas businesses in the domestic sample may understate the beta estimates as:[83]

> This is based on a view that regulated gas businesses may have a higher level of business risk arising from such factors as higher volume risk.

However, the consideration of a wider sample of listed businesses improves the statistical reliability of the beta estimates.

Table A.1 also reports each company's debt-to-value ratio. Since book values of debt are typically updated semi-annually, this ratio has been computed as the average net debt-to-value ratio sampled semi-annually over the period for which data for each company are available. Specifically, the ratio is calculated at the end of each June and the end of each December. The firm value is calculated as the sum of net book debt and the market value of equity. The data for the nine Australian regulated energy businesses are from Bloomberg information service.

Table A.1

Company	Ticker	Period	Debt-to-Value
Alinta Limited	AAN	01/01/2002 – 16/08/2007	0.341
The Australian Gas Light Company	AGL	01/01/2002 – 11/10/2006	0.272
APA Group	APA	01/01/2002 – 29/05/2009	0.553
Duet Group	DUE	12/08/2004 – 29/05/2009	0.759
Envestra Limited	ENV	01/01/2002 – 29/05/2009	0.721
GasNet	GAS	01/01/2002 – 14/11/2006	0.641
Hastings Diversified Utilities Fund	HDF	10/12/2004 – 29/05/2009	0.374
Spark Infrastructure Group	SKI	01/03/2007 – 29/05/2009	0.491
SP AusNet	SPN	15/12/2005 – 29/05/2009	0.592

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[82] AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 255.

[83] AER, *Electricity transmission and distribution network service providers, Review of the weighted average cost of capital (WACC) parameters: Final Decision*, May 2009, page 258.

A.3. Fama-French Risk Factors

The Fama-French three-factor model uses the following three factors:

§   the excess return to the market over the risk-free rate;

§   the *HML* factor; and

§   the *SMB* factor.

The market return has been calculated from the percentage change in the S and P All Ordinaries Accumulation Index. Monthly data for the other two Fama-French factors have been provided by Dimensional Fund Advisors Australia Ltd (DFA).

From January 1980 through June 1989, DFA compute the *HML* factor as the difference between the with-dividend returns to the Fama-French Australian Value Index and the Fama-French Australian Growth Index. From July 1989 through May 2009, DFA compute the *HML* factor as the difference between the with-dividend returns to the S and P Australian BMI Value Index and the S and P Australian BMI Growth Index. BMI stands for Broad Market Index. The Index is described as being broad because it includes both large firms and small firms.

From January 1980 through December 1990, DFA compute the *SMB* factor as the difference between the with-dividend returns to an ASX Ex-50 Leaders Simulated Index and the ASX 50 Leaders Index. The term 'ASX Ex-50' means outside of the ASX 50. The Simulated Index was sourced from John Nolan and Associates (now JANA). From January 1991 through May 2009, DFA compute the *SMB* factor as the difference between the with-dividend returns to the S and P ASX Small Ordinaries and the S and P ASX 100 Index.

Weekly values of the *HML* and *SMB* factors have been computed for the period from 4 January 2002 to 29 May 2009 to correspond with the monthly values provided by DFA. Weekly values for the *HML* factor have been computed as the difference between the weekly with-dividend returns to the S and P Australian BMI Value Index and the S and P Australian BMI Growth Index. Weekly values of the *SMB* factor have been computed as the difference between the weekly with-dividend returns to the S and P ASX Small Ordinaries and the S and P ASX 100 Index. The weekly data have been accessed from either Bloomberg or FactSet information services.

Appendix B.   Alternative Data Sources

In this appendix we investigate the effect of using alternative measures for the Fama-French factors. In particular, we examine the impact of using factors constructed from data supplied by Morgan Stanley Capital International (MSCI).

We use as a proxy for the market return the gross return to the MSCI Australian Standard Core portfolio. We compute the HML factor as the difference between the returns to the MSCI Australia Standard Value and MSCI Australia Standard Growth portfolios. We compute the SMB factor as the difference between the returns to the MSCI Australian Small Core and MSCI Australian Large Core portfolios. Data on the MSCI Australian Standard Core portfolio are available from January 1970 through May 2009, data on the MSCI Australian Standard Value and Growth portfolios are available from January 1975 through May 2009 while data on the MSCI Australian Small and Large Core portfolios are available from June 1994 through 2009 and from January 2001 through May 2009. The short time series of small company returns makes it difficult to estimate the SMB premium precisely.

B.1. Results

B.1.1. Risk premiums

We used the same estimate of the market risk premium as that employed by the AER, ie, 6.50 per cent per annum. Again, this estimate includes an amount that recognizes the value of franking credits to the investor.

Once more, to estimate the risk premiums on the *HML* and *SMB* factors we first formed annual returns from the monthly MSCI data we assembled. We then computed the arithmetic mean of the difference between the annual returns to the high book-to-market and low book-to-market portfolios and the arithmetic mean of the difference between the annual returns to the portfolios of small companies and big companies. We then adjusted these mean differences to take into account the value an investor places on franking credits distributed.

The table below shows estimates of the *HML* and *SMB* premiums computed using the MSCI data. Both the *HML* and *SMB* estimate are positive but neither estimate is significantly different from zero at conventional (5 per cent) levels.

Table B.1

	Market Risk Premium	*HML* Premium	*SMB* Premium
Australia	6.50	3.58	3.88
		(2.84)	(3.84)
Period		1975 – 2008	2001 – 2008

Premium estimates in percent per annum are outside of parentheses. Standard errors are in parentheses

B.1.2. Beta estimates

We computed beta estimates for the nine individual securities and for two portfolios of the securities, one equally weighted and the other value-weighted, using weekly and monthly data as before.

Tables B.2 through B.4 show estimates of the betas of the nine utilities relative to the three Fama-French factors. Again, the estimates are typically not very precise and the monthly estimates are less precise than the weekly estimates.

Table B.2
Individual security market beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	1.35	0.87	0.61	0.32	0.33	0.29	1.52	0.53	0.14
	(0.22)	(0.18)	(0.08)	(0.06)	(0.05)	(0.10)	(0.22)	(0.15)	(0.09)
LAD	0.87	0.85	0.63	0.19	0.27	0.25	0.84	0.39	0.10
	(0.23)	(0.29)	(0.07)	(0.05)	(0.03)	(0.13)	(0.11)	(0.15)	(0.07)
					Monthly data				
OLS	0.87	1.00	0.82	0.38	0.49	0.49	-0.10	0.46	0.14
	(0.50)	(0.33)	(0.20)	(0.16)	(0.15)	(0.20)	(0.84)	(0.29)	(0.22)
LAD	1.18	0.81	0.87	0.57	0.46	0.28	1.15	0.36	-0.06
	(0.39)	(0.37)	(0.17)	(0.13)	(0.09)	(0.15)	(0.45)	(0.26)	(0.20)

Standard errors are in parentheses.

Table B.3
Individual security *HML* beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	0.24	0.17	0.07	0.09	0.23	-0.15	1.62	0.36	0.29
	(0.24)	(0.19)	(0.09)	(0.07)	(0.06)	(0.10)	(0.26)	(0.18)	(0.10)
LAD	0.10	0.21	0.16	0.10	0.13	-0.15	0.85	0.23	0.18
	(0.24)	(0.30)	(0.08)	(0.06)	(0.03)	(0.13)	(0.12)	(0.18)	(0.08)
					Monthly data				
OLS	0.21	0.93	0.18	0.11	0.47	0.49	0.61	-0.07	0.02
	(0.55)	(0.36)	(0.23)	(0.17)	(0.16)	(0.23)	(0.87)	(0.28)	(0.22)
LAD	0.56	0.93	0.22	0.23	0.50	0.18	0.89	-0.38	0.35
	(0.43)	(0.41)	(0.19)	(0.14)	(0.10)	(0.17)	(0.47)	(0.25)	(0.20)

Standard errors are in parentheses.

Table B.4
Individual security *SMB* beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	SPN
					Weekly data				
OLS	0.90	0.48	0.35	0.32	0.42	0.09	1.37	0.45	0.15
	(0.26)	(0.20)	(0.12)	(0.10)	(0.07)	(0.11)	(0.38)	(0.27)	(0.15)
LAD	0.79	0.37	0.47	0.34	0.27	0.08	0.52	0.33	0.38
	(0.26)	(0.32)	(0.10)	(0.08)	(0.04)	(0.14)	(0.18)	(0.26)	(0.12)
					Monthly data				
OLS	0.60	-0.33	-0.04	0.38	0.28	-0.01	1.90	0.00	-0.05
	(0.56)	(0.35)	(0.23)	(0.19)	(0.17)	(0.22)	(0.99)	(0.32)	(0.25)
LAD	0.25	-0.58	-0.28	0.41	0.13	-0.02	0.43	-0.15	0.35
	(0.43)	(0.40)	(0.20)	(0.16)	(0.10)	(0.16)	(0.53)	(0.28)	(0.24)

Standard errors are in parentheses.

Table B.5 displays our average and portfolio estimates that use the MSCI data. The evidence indicates that a utility stock has exposure to all three Fama-French factors. Also, the standard errors of the average and portfolio estimates are typically lower than their individual security counterparts. So the average and portfolio estimates are more precise than the security estimates and, partly as a result, there is for each parameter less variation across the estimates. As is true of Tables B.2 through B.4, the weekly estimates are more precise than their monthly counterparts. Also, once more, consistent with our discussion in the text, the standard errors attached to the average OLS estimates are higher than their equally weighted portfolio counterparts, although, again, not dramatically so.

Table B.5
Average and portfolio beta estimates computed using
DFA data from 1 January 2002 to 29 May 2009

	Market			*HML*			*SMB*		
	AV	**EW**	**VW**	**AV**	**EW**	**VW**	**AV**	**EW**	**VW**
	Weekly data								
OLS	0.66	0.61	0.55	0.32	0.37	0.25	0.50	0.50	0.40
	(0.06)	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.09)	(0.07)	(0.09)
LAD	0.49	0.51	0.55	0.20	0.25	0.22	0.39	0.30	0.27
		(0.05)	(0.06)		(0.06)	(0.07)		(0.08)	(0.09)
	Monthly data								
OLS	0.51	0.49	0.70	0.33	0.28	0.36	0.30	0.32	0.05
	(0.15)	(0.14)	(0.14)	(0.16)	(0.16)	(0.16)	(0.18)	(0.16)	(0.16)
LAD	0.62	0.68	0.71	0.39	0.46	0.48	0.06	0.23	-0.05
		(0.13)	(0.22)		(0.14)	(0.24)		(0.14)	(0.25)

Standard errors are in parentheses.

B.2. Conclusion

Table B.6 shows the average and portfolio beta estimates using the Fama-French three-factor model and the data supplied by Morgan Stanley Capital International. Again estimates derived from weekly data have significantly lower standard errors than those estimated from monthly data. Consequently, we propose to focus on estimates derived from weekly data rather than those estimated from monthly data.

As discussed in section 5.2.1, there is no clear reason to favour beta estimates computed using either OLS or LAD regressions. Furthermore, it is unclear whether an equally or value-weighted portfolio or an average of the firm risk premiums provides more precise estimates. In our opinion all weekly beta estimates should be considered. Accordingly we recommend one use the mean of the six weekly beta estimates to populate a domestic version of the Fama-French three-factor model.

Table B.6
Fama-French Three-factor Model
MSCI Data

		Market Beta	*HML* Beta	*SMB* Beta	Risk Premium
	Weekly Data				
OLS	Equally Weighted Portfolio	0.61	0.37	0.50	7.23
	Value-Weighted Portfolio	0.55	0.25	0.40	6.02
	Firm Average	0.66	0.32	0.50	7.37
LAD	Equally Weighted Portfolio	0.51	0.25	0.30	5.37
	Value-Weighted Portfolio	0.55	0.22	0.27	5.41
	Firm Average	0.49	0.20	0.39	5.41
	Mean Weekly Value	**0.56**	**0.27**	**0.39**	**6.14**
	Monthly Data				
OLS	Equally Weighted Portfolio	0.49	0.28	0.32	5.43
	Value-Weighted Portfolio	0.70	0.36	0.05	6.03
	Firm Average	0.51	0.33	0.30	5.66
LAD	Equally Weighted Portfolio	0.68	0.46	0.23	6.96
	Value-Weighted Portfolio	0.71	0.48	-0.05	6.14
	Firm Average	0.62	0.39	0.06	5.66
	Mean Monthly Value	**0.62**	**0.38**	**0.15**	**5.98**

Using the means of the weekly MSCI beta estimates as set out in Table B.6 with the risk premiums set out in Table B.1 as the parameters of a domestic version of the Fama-French three-factor model, the cost of equity for a gas distribution business would be as follows:

$$\text{E}(R_e) = R_f + b_e MRP + h_e HMLP + s_e SMBP,$$

where

R_f is the risk-free rate, which was 5.1123% for the 20 day up to and including the 29 May 2009;[84]

b_e is the market beta of 0.56;

h_e is *HML* beta of 0.27;

s_e is *SMB* beta of 0.39;

MRP   is the market risk premium of 6.50 per cent;

HMLP is the *HML* risk premium of 3.58 per cent; and

SMBP is the *SMB* risk premium of 3.88 per cent.

Applying these values, the cost of equity for a gas distribution business using MSCI data is 11.25 per cent, ie:

$$11.25\% = 5.11 + 0.56 \times 6.50\% + 0.27 \times 3.58\% + 0.39 \times 3.88\%$$

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[84]   Note that the sample period used in this section to estimate the risk-free rate is only indicative and that a different sample period may result in a different return on equity. Our analysis of the domestic Fama-French three-factor model suggests that the return on equity for a gas distribution business using MSCI data is 6.12 percentage points above the risk-free rate.

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