WACC Review: Final

Report Prepared for Vector

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Executive Summary

Synergies Economic Consulting has been engaged by Vector Limited to undertake a review of the Weighted Average Cost of Capital (WACC) to apply to its gas pipeline and electricity lines businesses in the context of Part 4 of the Commerce Act and the Commerce Commission's (the Commission's) associated development of an input methodology relating to the regulatory cost of capital. In undertaking this review we have referred to the Commission's Revised Draft Guidelines in relation to the estimation of the cost of capital, dated 19 June 2009 (the Guidelines), the panel of experts' *Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital Methodology*, as well as other relevant precedent.

An initial version of this report was submitted on the 14th of August. This more detailed version expands on some of that material presented in that report and provides recommendations on each parameter.

A summary of our assessment is as follows.

1. We are not seeking to propose substitution of an alternative model for the Brennan-Lally CAPM, however still consider the assumption of a closed economy to be extremely limiting, given foreign investors will have a practical influence on the values of a number of the key parameters.

2. We do not accept the adoption of a maturity for the risk-free rate that matches the term of the regulatory period because: (1) the NPV=0 test is not applied by managers in practice in making investment decisions; and (2) this ignores refinancing risk. In practice, a large commercial business such as Vector would fund its long-term assets with at least some long-term debt. The Commission has already acknowledged that the interest rate risk associated with this could be managed by hedging. Hence, if the term of the risk-free rate continues to be set with reference to the length of the regulatory period, the hedging costs should be reflected in WACC or alternatively compensation be provided in allowed costs.

3. In relation to capital structure, we have:

    - examined the sample of comparator firms that we have also used for the beta analysis (which are mainly US firms);

- examined the sample of Australian energy utilities considered by the Australian Energy Regulator (AER) as part of the development of its recent Statement of Regulatory Intent (SoRI) on WACC; and
- examined observed book values for some of the major New Zealand energy utilities over the past five years.

Based on this assessment we consider that a capital structure range of between 40% and 60% is appropriate for a gas or electricity network business. We are of the view that a point estimate at the mid-point of this range, being 50%, is appropriate for Vector.

4. While the Commission has previously adopted a value of zero for the debt beta, in the Guidelines it has indicated that it may now adopt a positive number, although the methodology and the possible order of magnitude of the estimate remain unclear. The difficulties in estimating debt beta have been recognised by others (including Lally). While alternative methods have been proposed, there is currently no robust, accepted methodology of deriving a reliable estimate for the debt beta.

   Given any CAPM-derived estimate will always overstate the value of the debt beta given the extent to which the debt margin is driven by non-systematic risks, this methodology must be discarded. While we acknowledge that the debt beta may have some positive value, in the absence of any reliable methodology to measure it we are of the view that it should be set at zero.

5. In reviewing the beta assumption, we:

   - undertook a first principles analysis;
   - examined a sample of listed gas and electric utilities, most of which are domiciled in the US. We limited our sample to firms with 60 months of data, and eliminated any estimates that failed our statistical filters; and
   - examined rolling betas for the most relevant firms using data since 1999.

   Lally has previously concluded that 0.3 is an appropriate estimate of the asset beta for US utilities. Based on the results of our comparator analysis, we cannot conclude that an alternative estimate is materially better than this estimate. Adjustments then need to be applied to:

   - reflect differences between rate of return regulation (as applied in the US) and a five year price cap. The estimated uplift for a five year price cap is

0.2. As we understand that Vector's regime will be equivalent to a five year price cap, it is appropriate to apply the full amount of this increment here;

- the differences in the systematic risk of gas versus electricity (Lally added 0.1 for gas).

Overall, we concur with these adjustments. On this basis, we will arrive at an asset beta of 0.5 for electricity and 0.6 for gas. As there has been a gradual increase in betas for our most relevant US comparators in the last five years, we are of the view that there is no basis to reduce the beta below these estimates.

6. It remains difficult to estimate the MRP with any certainty, particularly when applying it as a proxy for the forward-looking MRP. Given the number of issues surrounding the estimation of the MRP and the debate that has occurred in previous regulatory decisions, we found it particularly surprising that relatively little attention was given to this issue by both the Expert Panel and the Commission. We consider it important that this issue is given a thorough review.

   The fundamental problem in this context is the difficulty in determining a robust estimate from New Zealand market data. We support the Commission's recognition of the benchmarking approach to estimating the MRP. The approach is well supported in the literature. Evidence from the literature generally suggests that the US is a good starting point. This then needs to be adjusted for differences between the US and New Zealand.

   Assessing the available literature and evidence reveals a range for the US MRP between 3% and 7% (which is quite wide). We consider that the mid-point of this range, being 5%, is an appropriate estimate of the forward-looking, long-horizon US MRP. To estimate a long-horizon MRP for New Zealand, we conclude that 2.5% should be added for market differences. Differences in taxation and country risk do not necessarily warrant further adjustment (noting that taxation differences may justify a small reduction in our 2.5% margin).

   In our opinion, this analysis indicates that an adjustment to the US MRP should be an increase of about 2.5% or slightly less. We combine this with our estimated long-horizon MRP for the US of 5%. Therefore, in our opinion, an appropriate estimate of a long-horizon MRP for New Zealand is 7.5% under the standard CAPM.

As the Commission favours using the simplified Brennan-Lally version of the CAPM, a further upward adjustment of approximately 1.5% is required. This brings our estimate of the post tax MRP to 9.0%.

It should also be noted that this report has not addressed the debt margin, or debt and equity raising costs. These are being considered in a separate report for Vector that is being prepared by ABN Amro.

Contents

1 Introduction

Synergies Economic Consulting (Synergies) has been engaged by Vector Limited (Vector) to recommend an appropriate Weighted Average Cost of Capital (WACC) to apply to its gas pipeline and electricity lines businesses in the context of Part 4 of the Commerce Act and the Commerce Commission's (the Commission's) associated development of an input methodology relating to the regulatory cost of capital. In doing this, we will identify, if relevant, any key differences between the WACCs that would apply to electricity lines and gas pipeline businesses that are subject to regulatory control.

In undertaking this review we have referred to the Commission's Revised Draft Guidelines in relation to the estimation of the cost of capital, dated 19 June 2009 (the Guidelines) and the panel of experts' *Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital Methodology*. We have also considered previous determinations by the Commission, including its 2008 *Authorisation for the Control of Supply of Natural Gas Distribution Services by Powerco Ltd and Vector Ltd* (the 2008 Authorisation). We have also had regard to other relevant regulatory precedent, as well as generally accepted commercial practices. Overall, we recognise that any departures from the principles and parameter values set out in the Guidelines needs to be supported by evidence to show that the alternative is a materially better approach or outcome.

An initial version of this report was submitted on the 14th of August. This more detailed version expands on some of that material presented in that report and provides recommendations on each parameter.

The report addresses the following areas:

- methodological issues (section 2);
- risk-free rate (section 3);
- capital structure (section 4);
- debt beta (section 5);
- equity beta (section 6); and
- market risk premium (section 7).

Other key issues that we have not considered in this report are:

- the debt margin; and
- debt and equity raising costs.

These matters are addressed in a separate report that has been prepared by ABN Amro.

2 Methodology

2.1 Uncertainty in WACC estimation

One of the reasons that WACC estimation in regulatory determinations can prove so controversial is because it often involves the pursuit of precision in areas that remain inherently uncertain. For example, notwithstanding the efforts that have been made to improve beta estimation, it remains highly susceptible to estimation error (this is considered in more detail later). Further, it remains well recognised that the 'optimal' level of gearing for a firm in a given industry is more likely to sit within a range, rather than represent a precise estimate.

We therefore endorse the Commission's intention to apply 'reasonableness' checks, such as financeability tests. We also endorse its recognition of the asymmetric consequences of error by selecting a WACC from above the mid-point of the range.

At the same time, the 'checks and balances' that the Commission proposes in themselves introduce some additional uncertainty for regulated businesses. For example, it is proposed that alternative models to the Capital Asset Pricing Model (CAPM) may be applied. However, it is not clear under what circumstances that might occur or what weight would be given to those models.

The CAPM has a number of recognised deficiencies however there currently remains no widely accepted alternative that could serve as a more superior asset pricing model. While alternatives can be used to test the reasonableness of the outcomes produced by the CAPM, it is not clear what would happen if there were significant differences between the outcomes produced by alternative models. What this may necessitate is an adjustment to the WACC range, or further consideration of where the point estimate is selected from within that range.

It is certainly clear that a degree of judgment needs to be applied and that is reflected in our assessment. In our view, the key test that should be applied is whether the proposed estimate put forward by the regulated business lies within a reasonable range of outcomes, not whether one estimate is better than another. The Guidelines retain considerable discretion for the Commission, which creates uncertainty for the regulated business.

2.2 Form of the CAPM

The standard form of the CAPM is extensively used globally for estimating the cost of equity capital. Motivated by the introduction of dividend imputation, the post-tax CAPM developed by Michael Brennan was adapted to New Zealand by Martin Lally and others. The result has been widely referred to as the Brennan-Lally CAPM. A simplified version of this model has been adopted by the Commission. Although reservations were expressed by the Commission's independent experts, the Commission has decided to continue using the model.

Our primary concern with the Brennan-Lally CAPM is the assumption of a closed economy. For example in Australia, in its Statement of Regulatory Intent (SoRI) the Australian Energy Regulator (AER) recently determined that it would recognise the presence of foreign investors in the domestic capital market, notwithstanding that the Officer WACC framework has often been applied based on an assumption of full segmentation from the global economy[1]. In our view, this approach is realistic as it recognises the practical influence that foreign investors can have on some of the key WACC inputs, without necessitating the application of a model that assumes full integration with the world economy.

The assumption of a closed economy may be reasonable to assume for some of the smaller Trust-owned electricity lines in New Zealand who can raise most of their external funding from the domestic market. However, for a business of a size such as Vector - even if we considered the gas and electricity networks businesses separately - it is questionable whether it would be able to source all of its external funding requirements from the New Zealand market, particularly if it wants to secure at least some of its funding for longer terms (this issue is especially relevant in the current market environment). Similar arguments apply in relation to raising equity capital.

Further, in the case of both debt and equity, given the volumes that are likely to be involved, if it is assumed that all funding is raised in the domestic market – and this could actually be achieved – the costs could be particularly significant. These costs would not necessarily be consistent with the costs of debt and equity as they are currently estimated by the Commission.

We concur with the Commission that only a single version of the model can be used. It is also recognised that each version has its own advantages and disadvantages. Given that the Commission has made it clear that it will continue to apply the Brennan-Lally

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[1] Australian Energy Regulatory (2009), Electricity Transmission and Distribution Network Service Providers - Statement of the Revised WACC Parameters (Transmission), Statement of Regulatory Intent on the Revised WACC Parameters (Distribution), May.

CAPM (after noting the potential issues with assuming a closed economy), we have applied that version here. However, we are of the view that caution needs to be exercised when interpreting outcomes while ignoring the practical influences that overseas investors will exert in the New Zealand market.

3 Risk free rate

We note that after considering the views of the various stakeholders (and the Expert Panel), the Commission remains committed to setting the risk-free rate based on the maturity that matches the length of the regulatory period. This is different to the practice adopted by all Australian regulators, for example, who use a ten year bond maturity. This includes the AER, who proposed the use of a maturity that matched the length of the regulatory period in its Draft SoRI, before subsequently reverting to the use of a ten year maturity based on evidence submitted by the regulated businesses, which showed that they do seek to obtain funding for longer terms. In making that determination the AER acknowledged that the assumption of a shorter term would increase refinancing risk.[2]

3.1 The NPV=0 requirement

The Commission's preference to use a rate that matches the term of the regulatory period is based on the proposition that it is necessary to maintain NPV neutrality. This in turn has been based on the recommendation of Professor Lally.

We do not accept that NPV=0 is a valid test for determining an appropriate cost of capital for a company (regulated or unregulated). There are two main reasons why we do not accept it. The first is that managers will only choose to invest in positive NPV projects (as otherwise they will not be adding value to the firm). The second is that the assumptions that Lally has applied in reaching his conclusions are highly simplified. We will address each of these in turn.

3.1.1 The investment decision in practice

The objective of a company is to create value for shareholders. Management of a company should make investments that satisfy this objective. That means only invest in projects where NPV is greater than 0. Stated another way, the costs of a project should be less than the benefits.

Textbooks in corporate finance and financial management state the decision criteria for investments as invest if NPV > 0.

[2] ibid., p.173.

> We should undertake projects with a positive NPV. That is, good projects are those for which the present value of the benefits exceeds the present value of the costs.[3]

There is considerable research on investment decision making in the "real world". Research shows that the hurdle rates (that is, cost of capital rates for approving investment proposals) used by companies are not consistent with what the CAPM suggests, where only systematic risk is rewarded with higher return. Companies use hurdle rates that are much higher than they would be if only systematic risk needed compensation.

In fact, authoritative studies have found that companies use hurdle rates that are twice as high as those implied by the CAPM.[4] It has been argued that the high hurdle rates are only an attempt to correct for excessive optimism of managers in their projections of outcomes of possible investments. This explanation likely has an element of truth, but it is a partial one at best.

A number of survey studies on the topic find that it is concern about project-specific risk, rather than behavioural issues, which primarily explains the use of hurdle rates that in CAPM terms are too high.[5] Other studies show that firms increase their hurdle rates when increases occur in factors that increase diversifiable risk but do not increase systematic risk,[6] again inconsistent with the cost of equity capital being exclusively determined by the CAPM.

It is important to note that most surveys of corporate capital budgeting find that most companies use some form of the CAPM as an input into their choice of hurdle rates. However, it is rare for firms to rely mechanically on the CAPM. Rather, the hurdle rates are informed by a wider set of considerations, including what is commonly regarded as diversifiable risk.

A recent research project used surveys of managers as well as firm data to ascertain how required rates of return for investments were set. They find that hurdle rates are set considering both systematic and non-systematic risk. Further, they find that the

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[3] J. Berk, P. DeMarzo & J. Harford (2009), Fundamentals of Corporate Finance, Pearson International Edition, p. 74.

[4] L. Summers (1987), "Investment Incentives and the Discounting of Depreciation Allowances" in M. Feldstein, ed. The Effects of Taxation on Capital Accumulation, University of Chicago Press, Chicago; and J. Poterba & L. Summers (1995), "A CEO Survey of US Companies' Time Horizons and Hurdle Rates", Sloan Management Review, 37(1), pp. 43-53.

[5] T. Mukherjee, & V. Hingorani (1999), "Capital Rationing Decisions of Fortune 500 Firms: A Survey" Financial Practice and Education, 9(1), pp. 7-15.

[6] J. Graham, & C. Harvey (2001), "The Theory and Practice of Corporate Finance: Evidence from the Field", Journal of Financial Economics, 60, pp. 187-243; and T. Keck, E. Levengood & A. Longfield (1998), "Using Discounted Cash Flow Analysis in an International Setting: A Survey of Issues in Modelling the Cost of Capital", Journal of Applied Corporate Finance, 11(3), pp. 82-99.

hurdle rates used for decision making exceed the conventionally calculated WACC by a substantial magnitude - over 5%. The research goes on to determine that the difference is "related to factors that reflect financial flexibility considerations, managers' confidence in the estimates of beta, financial health of firms, and the past performance of the industry they are in."[7]

Clearly, it is not only systematic risk that affects required returns.

This is confirmed by other empirical evidence. It is well known that, even in strongly competitive markets, firms take decisions that would be inefficient and value destroying if diversifiable risk did not matter. Firms not only normally buy insurance against what seem to be firm-specific risks (such as the risk of fire) but also routinely hedge the risks associated with exposure to fluctuations in interest rates, exchange rates and commodity prices. What is especially striking is that the greatest use of such hedging is made by relatively larger firms, which would be expected to be owned by the most widely diversified investors.[8] These observed behaviours would not be rational if all the assumptions of the CAPM held but can be rational in a world with transactions costs, information asymmetries, expected returns that are not normally distributed, and unavoidable non-systematic risks.

We approve of the use of the CAPM and WACC models in determining an appropriate cost of capital for regulated businesses in New Zealand.

However, we also believe there is a compelling case that these models should be supplemented in those areas where it is clear that they will result in estimates of the cost of capital that are too low and will thus not provide an adequate reward for the risks faced by a regulated business.

3.1.2 Importance of refinancing risk

Lally's conclusion is based on what Lally himself acknowledges as highly simplified assumptions. Under his model:

> ...the only source of uncertainty is in future real interest rates. [9]

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[7] I. Meier & V. Tarhan (2007), "Corporate Investment Decision Practices and the Hurdle Rate Premium Puzzle", http://ssrn.com/abstract=960161.

[8] See for example, W. Dolde (1993), "The Trajectory of Corporate Financial Risk Management", Journal of Applied Corporate Finance, 6, pp.33-41.

[9] M. Lally (2002), Determining the Risk Free Rate for Regulated Companies, Paper Prepared for the Australian Competition and Consumer Commission, August.

In particular, this assumes that there is no refinancing risk when debt matures. If real interest rate risk is the only risk that is considered, then it will be optimal to match the term of the funding with the term of the regulatory period. This of course assumes that the interest rate achieved on the debt matches the cost of debt set by the regulator, which in turn requires that the entire debt portfolio is refinanced over the same period that the risk-free rate is set.

Notwithstanding that this model is acknowledged as being highly simplified, its conclusions have been relied upon with no consideration given to the actual commercial and regulatory environment.

Refinancing risk is of fundamental importance when a business determines its funding strategy. Ignoring this risk is too far an abstraction from reality. If refinancing risk is considered, limiting the term of any funding to the term of the regulatory period will fail the NPV=0 test.

As outlined above, in order to minimise refinancing risks and ensure that the actual cost of debt was as close as possible to the regulated cost of debt, this would involve refinancing the entire portfolio around the reset dates.

Clearly, this is neither realistic nor prudent for most businesses, including Vector. There are two main reasons for this. First, this would expose the business to significant refinancing risk based on the market conditions prevailing at the time of reset (which the market may also be sensitive to, and could potentially take advantage of). It may be possible that the business is unable to refinance all or part of its debt during this period.

Second, if the business seeks to refinance towards the end of the current regulatory period, there is still uncertainty surrounding the actual regulated cash flows that will apply during the next regulatory period (and future periods). This could impact on the amount of funding that a lender is willing to provide, and/or the cost of that funding.

The Commission does acknowledge that:

> Regulated firms may borrow for periods longer or shorter than the regulatory cycle if they wish. Any interest rate risk associated with doing so could be offset in the interest rate swap market.[10]

[10] Commerce Commission (2009), Revised Draft Guidelines: The Commerce Commission's Approach to Estimating the Cost of Capital, 19 June, para.148.

There are two difficulties with this. First, it imposes a cost of hedging on the business that is not currently compensated (noting that these costs would not otherwise be incurred if the business was not regulated because it would not be required to hedge its risk in this way). Second, it only manages the interest rate risk associated with the fixing and periodic reset of the regulated cost of debt. However, the underlying refinancing risk on its physical debt portfolio remains unchanged.

The ignorance of refinancing risk in justifying the use of a risk-free rate that matches the term of the regulatory period is not realistic. In order to hedge this risk businesses will incur costs that are currently not compensated. This will result in a negative NPV outcome for the business, rather than a zero NPV.

Overall, the regulatory regime should complement prudent commercial risk management practices, rather than drive this behaviour. An appropriate strategy for an owner of network infrastructure (which has a long economic life) is to fund the business with long term debt, while maintaining appropriate maturity date diversification to manage interest rate, liquidity and refinancing risks. This is considered good treasury management policy.

A further risk that has not been considered here is the exposure that the businesses have to interest rates on new borrowings undertaken to fund capital expenditure during the course of the regulatory period. This is a separate issue that could be considered as part of debt raising costs (to the extent that it is prudent to hedge at least part of this exposure).

3.2 Recommendation

We do not accept that NPV=0 is a valid test for determining an appropriate cost of capital for a regulated business. This is because:

- in making investment decisions, managers seek a positive NPV (as this will add value to the firm); and
- Lally's NPV=0 principle ignores refinancing risk, which is a particularly significant issue if the term of the risk-free rate is aligned with the length of the regulatory period.

Economic regulation should complement efficient commercial decisions by regulated businesses. In our view, the rational benchmark firm will set the term of its debt funding in the most efficient manner, and it should not be rewarded for inefficient financing practices. The evidence clearly shows that businesses with long term assets will seek to fund themselves for longer terms. They also seek to maintain some

portfolio diversification to manage interest rate, liquidity and refinancing risks. This is efficient commercial practice.

Our recommendation is that the risk-free rate is therefore based on a ten year bond maturity. If a maturity that matches the term of the regulatory period continues to be applied, we would recommend that at minimum, the hedging costs should be reflected in WACC or alternatively compensation be provided in allowed costs.

4 Capital structure

4.1 Overview

It is not possible to readily identify a single 'optimal' capital structure for any firm, in any industry. Instead, we consider it more appropriate to focus on determining the optimal 'range' for the industry. The lower bound of that range recognises the benefits of gearing that accrue to the firm (including its relatively lower cost and possible tax advantages). The upper bound reflects that there is a point beyond which taking on additional borrowings will expose the firm to financial distress. This will be largely driven by the firm's risk profile, which will depend on the nature of its industry as well as firm-specific characteristics.

4.2 The importance of capital structure

A business can choose any mixture of debt and equity that it desires. A business could fund further capital expansions through the use of debt and increase the proportion of debt funding, thereby increasing the debt to enterprise value[11] ratio (D/EV). Alternatively, it can reduce dividend payouts and retain the equity funds for new investments, thereby reducing the D/EV ratio. In general, such restructurings take place whenever the business substitutes one capital structure for another.

Since the assets of a business are not directly affected by a capital restructuring, the business's capital structure decision can be examined separately from its other activities. This means that a business can consider capital restructuring decisions in isolation from its investment decisions.

An entities' capital structure can have important implications for the value of the business and its cost of capital. The important elements of the capital structure decision are easy to identify, but precise measures of these elements are generally not obtainable. As a result, one can only answer the question, "What the best capital structure might be for a particular firm at a particular time" by reference to a range.

It is assumed that the guiding principle is to choose the course of action that maximises the value of the firm. In theory, a particular D/EV ratio represents the optimal capital structure if it results in the lowest possible Weighted Average Cost of Capital (WACC).

[11] Enterprise value is the sum of interest bearing debt and the market value of equity less cash or near cash equivalents. It is a measure of gearing.

In this section, the advantage of financial leverage is explained and the key drivers of capital structure choice are identified. The key drivers of the advantage from leverage are the nature of business, taxation and financial distress. Each of these is considered in turn.

There does not exist an identifiable single point estimate that maximises firm value. A range of appropriate values can be estimated by considering key drivers. This section considers the key drivers and the next section assists in determining a range from an analysis of comparative data. Finally financial ratios are considered to determine where a capital structure for Vector may fall.

4.3 The effect of financial leverage

Financial leverage refers to the extent to which a firm relies on debt. The more debt financing a firm uses in its capital structure, the more financial leverage it employs. Financial leverage can dramatically alter the cash flows to the owners of the business as debt magnifies profits and losses. The effect on profits is not a windfall gain, it is a return for the additional risk to which the firm becomes exposed through the increased leverage. Greater profits are as a consequence of greater risks and the risk introduced by financial leverage is financial risk.

The magnification in returns is due to the cost of debt being less than the benefit from using the debt. When this is the case, the net difference accrues to the owners of the business (manifesting in valuation accretions). The owners obtain a return on their funds plus the additional return from the use of debt. If the net difference between the benefit of using the debt and the cost of the debt is negative, the difference erodes the returns to the owners of the business.

Debt typically has a lower cost than equity. The reason for the lower cost is twofold:

- the interest repayments on debt are tax deductible. Equity, on an after tax cost of funds basis, has a higher cost; and
- in the event of financial distress, debt-holders get paid before shareholders. Debt-holders therefore have less default risk than shareholders and all else being equal, demand a lower rate of return than shareholders.

Thus taxation and the costs of financial distress or bankruptcy are two major considerations with respect to financial leverage and an optimal capital structure. These determinants are considered in turn.

4.4 Taxes

The use of debt results in two major consequences, one being a benefit and the other being a cost to the business. The benefit is considered in this section and the cost in the following section.

The advantage of debt to the business is the tax deductibility of the interest repayments. Interest repayments on debt are tax deductible whereas dividend payments are paid from after tax profits and hence non deductible for the business.

Where a business is a tax paying entity, the tax shield created by the interest is an advantage while the business is funding operations via the use of debt. As a business typically uses some debt funding each year, the yearly benefit of the tax shield can be seen as a perpetual benefit. The present value of the perpetual tax shield will equate to the corporate tax rate times the amount of debt outstanding.

Considering the tax deductibility only, the value of a geared or levered firm exceeds the value of an unlevered firm. The amount by which the levered firm exceeds the unlevered firm is the corporate tax rate (adjusted for imputation) times the level of debt funding. To maximise the value of the firm, a business should gear up as much as possible when considering only this factor and (incorrectly) ignoring all others. If there are other factors influencing capital structure choice, (which there are) then the optimal level of gearing is less than 100% debt funding. A key influence is the costs of financial distress.

4.5 Financial distress costs

One limit to the amount of debt a firm might use comes in the form of bankruptcy costs arising from financial distress. As the D/EV ratio rises, so too does the probability that the firm will be unable to pay its debt-holders. This is not to suggest the Vector will suffer from financial distress. However, debt-holders are price protected,[12] so the borrower pays for the possibility of financial distress in the form of a higher interest rate. This is an added cost of debt financing.

It is expensive to suffer from financial distress. The costs associated with financial distress (or the increased risk of financial distress) will eventually offset the tax related gains from leverage. It is the possibility of loss that limits the amount of debt that a

[12] Price protection is the phrase used to describe a situation where a debt holder is protected. If a lender perceives that there is financial distress, it will lend funds to the affected entity reflecting the perceived financial distress (through a higher interest rate). The borrower pays for the financial distress today and the lender is price protected.

firm will choose to use. The optimal capital structure is some debt and some equity. The benefits of debt need to be traded off against the costs of using the debt.

In the case of a competitive business, the riskiness of the business is assessed by the market and the borrower will pay a rate of interest that reflects the market's assessment of that risk. As the business borrows more funds the cost of debt may remain constant or rise. There may be no great change in the cost of funds while the business remains within its perceived borrowing capacity. Should the firm exceed its borrowing capacity the cost of debt rises dramatically.

Firms should borrow up to the point where the tax benefit from an extra dollar in debt is exactly equal to the cost that comes from the increased probability of financial distress. The maximum value of the firm is reached where WACC is at a minimum, so this is the optimal amount of borrowing.

4.6 Observed capital structure relationships

Taxation and bankruptcy costs drive capital structures. The third key driver is the nature of the business or business risk. Capital structures are similar for firms operating in the same industry type. If surviving competitors have low D/EV ratios, then the new firm entering the industry should copy the surviving firm. An approximation of the optimal capital structure is determined therefore by Natural Selection. We therefore concur with the Commission's approach of basing the capital structure assumption on an appropriate notional capital structure for the relevant industry. This involves examining gearing levels for similar firms, averaged over an appropriate period to recognise that actual gearing levels observed at any one point in time may not reflect the target level of gearing for that business (for example, this may be due to where it currently is in its capital expenditure cycle).

It is also important to consider this within the context of the implied credit rating. This includes testing the impact of different gearing levels on key financial ratios, which will in turn influence the credit rating. At the same time, to the extent that an industry benchmarking approach is being applied, we would need to be able to construct a 'typical' cashflow profile for the average firm (which may be different to Vector's actual cashflow profile), in order to be able to undertake any meaningful analysis. We have not done that here.

For the purpose of this assessment we have examined:

- the total sample of electricity and gas utility business;

- the sample of electricity and gas businesses that have been used for the purpose of the beta assessment (the comparator sample); and
- observed gearing levels for some Australasian energy businesses.

4.6.1 Comparative firms – total sample

Table 1 provides examples of gearing for US industry sectors. The two sectors considered are electricity utilities and natural gas utilities.

Table 1 Capital structure Debt to Enterprise Value

	2001	2002	2003	2004	2005	2006	2007	2008
Electric Utilities	48%	54%	53%	47%	45%	40%	40%	51%
Gas Utilities	42%	44%	39%	35%	35%	26%	32%	48%

Note: The averages in the table are simple averages.
Source: Bloomberg August 2009

Using a large sample has the effect of using diversification to remove idiosyncratic firm specific features allowing only electricity and gas characteristics to remain. Note that no two firms are the same, nor is any firm the same as Vector, but a large sample of firms provides guidance as to an appropriate capital structure. Given a range in capital structures and given a number of empirical observations, an appropriate level of gearing for Vector can be estimated.

In all years the number of firms in the total sample was approximately 120. It can be seen that the average for electricity utilities is slightly higher that for gas and that for both samples, the average is reasonably constant through time. A firm over time will move towards its optimal capital structure. Once the firm reaches its perceived optimal structure, in the short run, the firm will operate at or near its perceived optimal structure. D/EV ratios in the short run remain constant. This observation is evident in Table 1. It can be seen that the capital structure of electricity and gas businesses are relatively constant and there is little movement in the gearing over time.

Ratios have increased in 2008 due to the effect of the global financial crisis. While the amount of debt has not increased, the market value of equity has decreased resulting in the D/EV ratio increasing.

4.6.2 Comparator firms – selective sample

This sample comprises listed firms contained in the industry categories 'gas utilities' and 'electric utilities' (they are also used in the beta analysis). Using data from Bloomberg, we have obtained the average gearing levels for each firm over the last five years. Where rated, we have also obtained their current credit rating from Standard

and Poor's. Most of the firms are from the US. Differences in the average gearing levels for the different jurisdictions therefore also need to be considered.

As will be highlighted in the beta assessment, there are few comparators that are only engaged in transmission and/or distribution. We have therefore included firms that are engaged in transmission and/or distribution but also undertake other activities in the energy sector, such as generation. The implications of this will need to be considered when interpreting the results. Some firms are involved in both gas and electricity markets (the GIC classification reflects where most of the company's revenues are sourced). It should be noted that the sample is slightly larger than our beta sample as some of the firms failed our statistical filters for the purpose of the beta assessment. Descriptions of the companies are provided in Attachment A.

The average gearing levels of our sample of comparator gas utilities over the last five years is provided in the following table.

Table 2 Average gearing levels: gas utilities

Company	Debt/EV	Credit rating[a]
Mostly transmission/distribution		
Australia		
APA Group	57.4%	-
Envestra Limited	71.3%	BBB-
Canada		
Gaz Metro Limited Partnership	41.7%	A-
Pacific Northern Gas Ltd	55.8%	-
US		
AGL Resources Inc	44.8%	A-
Atmos Energy Corporation	48.4%	BBB+
Southwest Gas Corporation	54.9%	BBB
Chesapeake Utilities Corporation	35.1%	-
Piedmont Natural Gas Company	32.7%	A
WGL Holdings Inc	33.7%	AA-
Northwest Natural Gas Company	38.1%	AA-
The Laclede Group	43.6%	A
Corning Natural Gas	67.6%	-
RGC Resources Inc	41.0%	-
Integrated gas utilities (all US)		
EQT Corporation	19.7%	BBB
National Fuel Gas Company	27.7%	-
Energen Corporation	20.7%	BBB
UGI Corporation	44.7%	-
Ferrellgas Partners	45.7%	-
Delta Natural Gas Company	43.5%	-
Nicor Inc	37.4%	AA
South Jersey Industries Inc	34.5%	-

a As at 5 August 2009

Source: Gearing data: Bloomberg; credit ratings: Standard & Poor's

Some of the observations we can make from this data are as follows:

- the range for US firms engaged primarily in distribution or transmission is between 19.7% and 67.6%. The simple average is 40.5%;
- the Australian firms and one of the two Canadian firms are more highly geared. APA Group and Envestra's average gearing levels are 57.4% and 71.3% respectively.

In interpreting these numbers, consideration should be given to any differences between the various jurisdictions that might impact gearing levels. These issues are discussed further below.

The average gearing levels for electric utilities over the past five years are shown in Table 3.

Table 3 Average gearing levels: electric utilities (all US firms)

Company (Jurisdiction)	Debt/EV	Credit rating[a]
Mostly transmission/distribution		
Exelon Corporation	26.3%	BBB
Pepco Holdings Inc	55.9%	BBB
Integrated electric utilities		
FPL Group	39.5%	A-
Duke Energy Corporation	38.6%	A-
Entergy Corporation	37.8%	BBB
American Electric Power Company	49.0%	-
FirstEnergy Corp	41.5%	BBB
Allegheny Energy	43.1%	BBB-
Northeast Utilities	58.3%	BBB
DPL Inc	37.9%	-
NV Energy Inc	62.4%	BB
Westar Energy	47.5%	BBB-
Great Plains Energy Incorporated	40.8%	BBB
Cleco Corporation	40.4%	BB
Idacorp Inc	46.3%	BBB
Allete Inc	28.8%	-
Unisource Energy Corporation	66.5%	-
UIL Holdings Corporation	41.8%	-
El Paso Electric Company	41.5%	-
The Empire District Electric Company	45.6%	-
Central Vermont Public Service Corporation	39.2%	BB+

a As at 5 August 2009

Source: Gearing data: Bloomberg; credit ratings: Standard & Poor's

All of our firms are domiciled the US. The average gearing level for the two firms primarily involved in transmission and/or distribution are 26% and 55%. The average for the sample of integrated electric utilities was 44%.

Overall, while gas businesses appear to be slightly less reliant on debt than electricity businesses, the difference in gearing is not statistically significant. This is not considered surprising given the particularly imprecise nature of capital structure estimation and the reasonably wide range of outcomes observed. It is also not possible

to discern any differences between transmission and distribution to justify treating these differently for the purpose of estimating the optimal range of gearing levels. What we do observe, however, is that the credit ratings of the electricity utilities are lower than the gas utilities.

4.6.3 Australasian firms

In developing the SoRI, the AER examined a sample of Australian gas and electricity businesses as part of its review of the optimal gearing level of the efficient benchmark network service provider. The sources they reviewed included:

- market values from Bloomberg, for APA Group, DUET, Envestra, GasNet, SP AusNet, and Spark Infrastructure;
- book value analysis from Standard & Poor's, for CitiPower, Country Energy, the Dampier Bunbury Natural Gas Pipeline Trust, ElectraNet, Energy Australia, Energy Partnership (Gas) Pty Ltd, Envestra Victoria, Ergon Energy, ETSA Utilities, Integral Energy, Powercor and United Energy.

They also published an adjusted Bloomberg dataset that adjusted total debt to remove the effects of stapled securities, loan notes and double leveraging.

The average gearing levels are reported in the following table.

Table 4 AER: reported average gearing levels of gas and electricity utilities

Year	Bloomberg (market)	Bloomberg (adjusted)	Standard & Poor's	Average
2002	66.3	67.4	61.6	**65.1**
2003	63.9	63.7	66.7	**64.8**
2004	62.2	58.2	64.7	**61.7**
2005	62.8	63.3	67.8	**64.6**
2006	60.3	62.1	66.4	**63.0**
2007	58.7	57.8	65.1	**60.5**
Average	**62.4**	**62.1**	**65.4**	**63.3**

Source: Australian Energy Regulatory (2009), Electricity Transmission and Distribution Network Service Providers - Statement of the Revised WACC Parameters (Transmission), Statement of Regulatory Intent on the Revised WACC Parameters (Distribution), May, p.113.

The data on actual observed gearing levels reported by the AER provides clear support for the benchmark gearing level of 60% that was determined by the AER, and has been

consistently applied to distribution and transmission network businesses by all jurisdictional regulators in Australia.[13]

We have also examined gearing levels maintained by the major New Zealand gas and electricity utilities over the past five years. This is shown in Table 5.

Table 5 New Zealand utilities – gearing levels (book values)

Financial year ending	Vector	Powerco	Orion Group	Unison
2004	65.1%	64.8%	27.5%	47.4%
2005	53.8%	48.8%	19.6%	43.3%
2006	53.3%	61.9%	19.7%	33.7%
2007	56.5%	61.6%	26.3%	32.0%
2008	50.7%	74.8%	24.5%	46.0%
Average	**57.2%**	**59.3%**	**23.3%**	**39.1%**

Note: Based on non-current liabilities to total assets.

Given their relative size, we consider Vector and Powerco to be the most appropriate comparators for this purpose. The average gearing level of both firms over the last five years has been close to 60%. It is important to note that as these gearing levels are for the entire business, they do not necessarily reflect the gearing maintained by the gas and electricity transmission and distribution networks. However, all other things being equal, we would expect that the sustainable gearing for a regulated business activity is likely to be higher than the gearing level that could be maintained for other contestable activities.

4.6.4 Interpreting the data

It is difficult to draw any definitive conclusions from our comparator sample for a number of reasons. First, none of these firms are close comparators to a 'stand-alone' regulated gas or electricity network business. Unless each company publishes separate balance sheets for each business activity in the group (which is often not the case) and market data for each business segment is known, it will not be possible to make any robust adjustments to the firm-wide gearing level in order to estimate the gearing level of the transmission or distribution business.

Second, we have relied primarily on US data. The US data indicates that a level of gearing of around 40% appears reasonable where gearing is measured as debt as a proportion of enterprise value. As outlined above, consideration needs to be given to the average gearing levels between the US and New Zealand markets. Some of the key

[13] This was also prescribed in the National Electricity Rules for all transmission network service providers, as well as distribution network service providers in New South Wales and the Australian Capital Territory.

factors that could influence these differences include the relative tax advantage of debt, the depth and sophistication of the capital markets and the availability of risk management tools. Third – and this will also be an issue that will need to be considered for the beta analysis – most of these firms are likely to be in a more competitive market environment than a regulated New Zealand utility, particularly those firms that are integrated. In theory, as noted above, we would expect the gearing levels of the contestable activities, such as generation, to be lower than the gearing level that could be maintained for a transmission or distribution network business.

Overall, it is not clear what the net impact of these differences will be. For example, the relative depth and sophistication of capital markets in the US and the availability of risk management tools might facilitate higher gearing levels by firms in this market. On the other hand, those firms who are in more contestable markets and hence face higher risk, will only be able to maintain lower gearing levels.

In making comparisons between the different datasets, it is also important to note that there are some differences in the measurement basis for each. The Bloomberg data is based on interest-bearing debt to enterprise value. Our New Zealand sample is based on book values (which we understand is the Commission's preference).

In our view, the evidence from Australasian businesses is likely to be of most relevance to Vector. This is for a number of reasons. First, the businesses are largely involved in transmission and/or distribution, and a significant number are regulated. Second, the Australian and New Zealand tax regimes are similar, as are the size and sophistication of the domestic capital markets (particularly relative to the US).

Based on our assessment we consider that 40% is more likely to be at or towards the lower bound of a reasonable range. The upper bound of that range would be at least 60%. The mid-point of 50% is also the average of the total firm sample.

Given there is no clear difference between the gearing levels observed for gas and electricity businesses, it is considered appropriate to apply this same assumption to electricity and gas networks. There is also no evidence to suggest that different gearing levels should be applied to distribution and transmission.

4.7 Conclusion

Based on our assessment of comparative businesses (noting the numerous problems associated with the comparative study analysis), the likely range applicable for Vector's gas and electricity network is 40% to 60% where gearing is measured as debt to enterprise value (D/EV).

We conclude that a reasonable point estimate for Vector's gas and electricity network businesses at the current time is 50%. This is higher than the estimate previously determined by the Commission, which was 40%. Given capital structures are typically observed within a reasonably wide range, we do not consider it necessary to distinguish between gas and electricity for this purpose.

5 Debt beta

5.1 Commission's position

Historically, the Commission has applied a zero debt beta. From our review of the Guidelines, the Commission's position on this is very unclear. What it does conclude is that:

> When setting allowed rates of return, the Commission intends to estimate debt betas wherever feasible using the CAPM. If, for the reasons outlined above, reliable estimation proves infeasible, the Commission intends to draw on recent published evidence (which usually relate to overseas markets such as the US) to inform its view on the magnitude of (New Zealand) debt betas.[14]

This is of significant concern for two reasons. First, this position is very unclear and presents considerable uncertainty for regulated businesses. Second, as we will outline below, there is no generally accepted method to reliably estimate debt betas. Hence, we expect that reliable estimation will "prove infeasible". Further, we are not aware of any empirical evidence – from the US or elsewhere – that presents a method of estimating debt beta that has gained, or is likely to gain, widespread acceptance.

5.2 Problems with estimating the debt beta

The approach suggested by the Commission to estimate the debt beta uses the structure of the CAPM:

$$\beta_d = (R_d - R_f)/(E(R_m) - R_f)$$

Where:

β_d = beta of debt

$(R_d - R_f)$ = debt premium

$(E(R_m) - R_f)$ = market risk premium.

This has the appeal of using a familiar relationship between beta and the market risk premium $(E(R_m) - R_f)$. However, there are a number of problems. In application, the market return is measured as the return on an equity market. In principle, to be

[14] ibid., para. 195.

applied to debt, the market return should be measured with a market index that includes debt. Also, the approach attributes the total of the promised debt risk premium (R_d - R_f) to systematic risk. However, given it is recognised that a substantial determinant of the cost of debt is non-systematic default risk, this approach will significantly over-estimate the value of the debt beta.

An alternative approach is to assume the debt beta is zero. Lally has previously recommended the application of a debt beta of zero in a regulatory context:[15]

> …on account of the difficulties in estimating the debt beta, the slightness of the error in treating it as zero, the likelihood that the resulting errors are less than those arising from the Authority's current approach, and the likelihood that the errors will be of the less serious type than those arising from the Authority's current approach.

The Australian Competition and Consumer Commission (ACCC) considered this issue in the development of its *Statement of Principles for the Regulation of Electricity Transmission Revenues*.[16] It noted the uncertainty surrounding the estimate of the debt beta, particularly given that it was not generally used by investors, and that different approaches yield different outcomes. It determined that it would apply a value of between 0 and 0.2. Importantly:

> …the ACCC considers that the debt beta is immaterial as long as the same value is used in the de-levering and re-levering process.[17]

Most (but not all) of the State-based regulators now adopt zero. The preferred approach of both the ACCC and the AER is to adopt a value of 0.[18]

The fundamental deficiency of using the CAPM-based approach to derive the debt beta is that it will always overstate the debt beta given the debt margin is largely driven by non-systematic risk factors. This situation is exacerbated at the current time given the blow-out in credit spreads that have occurred due to conditions in global financial markets, with an increase in the debt margin resulting in a significant increase in the debt beta.

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[15] M. Lally (2004a), The Cost of Capital for Regulated Entities, Report prepared for the Queensland Competition Authority, p.75.

[16] Australian Competition and Consumer Commission (2004), Decision: Statement of Principles for the Regulation of Electricity Transmission Revenues – Background Paper, December.

[17] ibid.

[18] Australian Energy Regulator (2008), Explanatory Statement – Electricity Transmission and Distribution Network Service Providers, Review of the Weighted Average Cost of Capital (WACC) Parameters, December, p.201.

As noted above, the debt beta estimate is not considered a significant issue provided the same estimate is used in the equity beta de-levering and re-levering process. However, that in turn implies that the regulated entity's equity beta is being set with direct reference to the comparator data. When a higher value of debt beta is applied, for example, it will result in a relatively higher value for the de-levered asset betas (the comparators), and a lower equity beta when the regulated entity's asset beta is re-levered. In other words, this will prove 'immaterial' if the regulated entity's asset beta is set with *direct* reference to the comparator estimates.

This will not always be the case, particularly if the risk profile of the business is different to its comparators. More importantly, the fundamental issue here is whether there is a sound economic basis to support the estimated value for the debt beta. The potential anomaly is highlighted in the current environment with the increase in credit spreads.

As noted above, the cost of debt is largely driven by non-systematic default risk. There is no evidence to suggest that the expansion in credit spreads is due to an increase in the systematic risk of debt (that is, an increase in the covariance between the return on debt securities and the return on the market).

More specifically, this implies that there has been a global transfer of risk from equity holders to debt holders. There is no evidence that this has occurred nor is there any plausible reason why this would be the case. The more realistic scenario is that the systematic risk of debt has not changed and the movements in credit spreads are based on changes in perceived default risk (worsened by signalling problems associated with trading in the market for debt)[19].

In any case, as outlined above, given that the debt beta itself cannot be readily estimated the actual influence of systematic risk on corporate bond yields remains unknown.

What this highlights is the significant issues associated with deriving the debt beta using the CAPM. The sensitivity of the debt beta estimate to changes in the debt margin assumes that these changes are solely driven by systematic risk. As this relationship does not hold, it can actually produce an outcome which has no theoretical support and in fact may contradict what is more likely to be the case in practice.

[19] That is, given the heightened uncertainty associated with corporate debt investors perceive the desire of a debt holder to sell that debt as a 'signal' that the debt holder has inside information about the negative quality of the debt.

5.3 Recommendation

The difficulties in estimating debt beta have been recognised by others (for example by Lally, as outlined above). While alternative methods have been proposed, there is currently no robust, accepted methodology of deriving a reliable estimate for the debt beta. Given any CAPM-derived estimate will always overstate the value of the debt beta given the extent to which the debt margin is driven by non-systematic risks, this methodology must be discarded. While we acknowledge that the debt beta may have some positive value, in the absence of any reliable methodology to measure it we are of the view that it should be set at zero.

In our view, a debt beta of zero should be applied because there is currently no robust way of estimating a value that measures the systematic risk of debt only. This is particularly important given the asymmetric consequences of error. An assumption of zero has therefore been recommended for Vector.

6 Equity beta

6.1 Methodological issues

6.1.1 Approaches to estimating beta

There are three basic approaches to estimating systematic risk of equity, being:

1. *Direct Estimation.* If the firm is listed, regression analysis can be used to estimate the relationship between the firm's returns and the returns on the domestic share market index. At least several years of trading data is required to provide a statistically meaningful estimate. Also, the applicability of the estimated equity beta will depend upon whether the company is involved in business areas outside of the regulated activity being studied.

2. *First Principles.* This approach analyses the factors that impact the sensitivity of a firm's returns to movements in the economy or market. It can be used for two main purposes. First, it can be used to assist in the selection of comparable companies. Second, as the comparable companies analysis will tend to produce a range of plausible estimates for beta, the first principles analysis can assist in determining where the particular firm may be within that range based on its relative risk profile

3. *Comparable Companies.* This approach begins by identifying a set of comparable listed companies with a similar business and risk profile. Using share price information for the companies, their equity betas are estimated using regression analysis. As the companies will have different gearing levels (and hence different financial risk), these equity betas must be 'de-levered' to produce an asset beta.

Vector is a listed entity so it is possible to estimate a beta for the firm as a whole. However, the regulated network businesses are part of a larger portfolio of energy-related businesses held by Vector. As the risk profile of the regulated networks will be different from the risk profile of the entire (diversified) group, the beta estimate for Vector cannot be solely relied upon for this review.

A first principles analysis is considered of fundamental importance. While it is only a qualitative analysis, it provides important context for understanding the risk profile of the relevant industry and also assists in interpreting the beta estimates of the comparable companies. As suggested by the Commission, undertaking a similar analysis of the comparators used in the beta assessment would enable more robust conclusions to be drawn. However, it is not possible to access the necessary data from

each comparator to be able to do this. We have therefore undertaken an analysis on the assumption that the risk profile of Vector's gas and electricity network businesses is typical of the risk profile of this industry (which we think is a reasonable assumption to make).

It will also assist in understanding the extent to which there are differences between electricity and gas businesses, and transmission and distribution networks. In particular, we need to understand if those differences are likely to be sufficiently material to warrant a different beta estimate.

6.1.2 Problems in estimating beta

Before progressing to the more detailed analysis, it is important to be aware of the susceptibility of beta to estimation error. It is not possible to directly observe a firm's true beta. Instead, estimates are obtained by regressing the historical returns of a firm's shares against the historical returns for a market index, over the same time period. As with any statistical estimate, it is measured with uncertainty. This uncertainty is likely to be more pronounced for individual firms. As a consequence, the resulting data estimates can be of limited reliability and caution should be exercised in applying these estimates in a forward-looking analysis.

There are a number of ways to address measurement error. As a starting point, any beta estimates with poor statistical properties[20] should be discarded (this is discussed further below). There are a number of other ways to deal with the uncertainty surrounding the estimation of beta, including:

- adjusting for thin trading, which is a common cause of measurement error, using techniques such as the Scholes-Williams technique;

[20] The **R^2**, or coefficient of determination, measures the explanatory power of the regression equation (that is, how much of the variability in Y can be explained by X). It takes a value of between 0 and one. For example, an R-squared of 0.7 would suggest that 70% of the variability in the individual share's returns is explained by variability in the returns on the market. The **standard error** measures the sampling variability or precision of an estimate. That is, as the estimate is derived from a sample distribution, it measures the precision of the model parameter. A lower standard error is preferred as it indicates a more precise measure. A third commonly used measure is the **t statistic**. The t statistic is calculated for each coefficient in a regression model (in this case, the beta coefficient) for the purposes of hypothesis testing. The tendency is to test the hypothesis that the regression coefficient is significantly different from zero. This is done within a specified confidence interval (for example, 95%). Generally, the t statistic should exceed two to be considered reliable. These measures have been used in this analysis to screen comparator beta estimates.

- adjusting for mean reversion (i.e. the tendency for equity betas to move towards the equity beta of the market over time) using techniques such as the Blume and Vasicek adjustments[21]; and
- the formation of portfolios. Portfolio betas have substantially lower standard errors and yield more precise estimates of beta. While there are benefits in using this approach via reductions in the standard error, as more firms are used caution should still be exercised to ensure that they are relevant comparators.

A report by Gray et al provides a useful summary of the various methods of estimating beta, as well as their performance.[22] The study uses historical data to compare the predicted beta estimate in accordance with the CAPM, with the actual equity return for the relevant forecast period. The closer the predicted estimate to the actual equity return, the better the estimation technique. A summary of the findings of the report are:

- it is preferable to use data periods of longer than four years;
- monthly observations are preferred to weekly observations;
- Blume-adjusted estimates that account for mean reversion provide better estimates;
- statistical techniques that eliminate outliers are preferred, provided the outlier is not expected to re-occur; and
- a beta estimate derived from a sample of firms in an industry is preferred to an estimate for an individual firm.

The approach that has been applied in this review is outlined in section 6.3.1 below.

6.2 First principles analysis

A first principles analysis is a qualitative assessment of the firm's risk profile, the aim of which is to identify its systematic (or non-diversifiable) risk factors and assessing their likely impact on the asset beta. Lally identifies a number of factors to be considered here, including[23]:

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[21] The impact of this adjustment is to 'draw' the value of the estimated beta closer to one. The typical adjustment is simply: Adjusted beta = (1/3 * the market beta of one) + (2/3 * estimated beta). This can be reduced to: Adjusted beta = 0.33 + (0.67 * estimated beta).

[22] S. Gray, J. Hall, R. Bowman, T. Brailsford, R. Faff, and R. Officer (2005), The Performance of Alternative Techniques for Estimating Equity Betas of Australian Firms, Report Prepared for the Energy Networks Association.

[23] M. Lally (2008), The Weighted Average Cost of Capital for Gas Pipeline Businesses, 28 October.

- nature of the product or service;
- nature of the customer;
- pricing structure;
- duration of contracts;
- market power;
- nature of regulation;
- growth options; and
- operating leverage.

A number of these factors are interrelated – that is, the impact of one factor on beta could either be increased or lessened by another factor. Hence, while the impact of each factor can be considered in isolation, the overall assessment will reflect the net impact of the factors in combination. The first two factors are closely linked and so will be considered together.

6.2.1 Overview of Vector's business

Vector owns a range of energy and technology businesses, including:

- electricity distribution networks;
- gas transmission and distribution networks, as well as sales and processing;
- technology (energy metering and communications); and
- related services (training and vegetation management).

Vector owns two electricity distribution network businesses. Vector Limited distributes electricity to Auckland and the surrounding areas, and United Networks services the North Shore City, Waitakere City and the Rodney District.

Vector's gas transmission and distribution businesses cover the North Island of New Zealand. Vector owns and operates over 2,300 kilometres of high pressure gas transmission pipelines and operates a 313 kilometre high pressure onshore gas pipeline owned by Maui Development. It owns and operates over 10,057 kilometres of distribution pipelines.[24]

[24] www.vector.co.nz.

6.2.2 Nature of the product/nature of the customer

For the purpose of beta, the objective of understanding the underlying market for the relevant product is to identify the key drivers of demand and the extent to which these drivers have a relationship with domestic economic activity. This includes examining the income elasticity of demand for electricity and gas use, given incomes will have a direct relationship with Gross Domestic Product (GDP).

The dominant source of energy supply in New Zealand is oil. In 2007, it accounted for around 50.3% of consumer energy supply.[25] Oil's share of consumer energy supply increased by 0.8% between 2000 and 2007. The share accounted for by gas increased by 0.3%, whereas electricity's share fell by 0.9%.

For New Zealand as a whole, most of the demand for energy is unallocated (the Ministry of Economic Development assumes this is mostly transport) – this was 33% in 2007[26]. Industrial users accounted for 30.7% of energy demand, followed by commercial (19.1%), residential (12.6%) and agriculture (4%). Industrial users' share of demand increased by 2.3% from 2000, with the proportion accounted for by residential, commercial and agricultural users falling slightly.

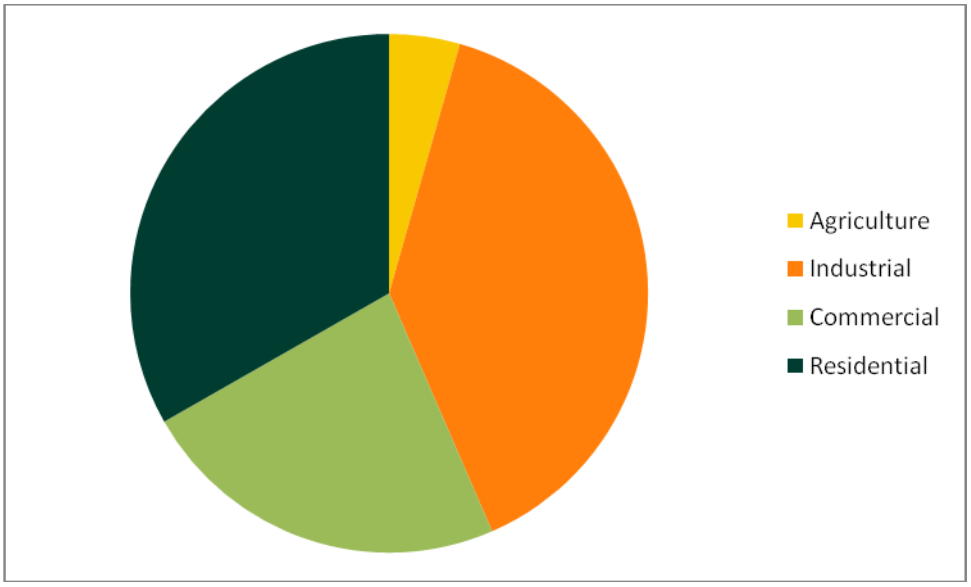
Electricity

Data from the Ministry of Economic Development shows that industrial users account for most of the demand, followed by residential consumers. The demand profile in 2007 (based on proportions of total demand) is shown below.

[25] Ministry of Economic Development (2008), New Zealand Energy in Brief, August 2008.

[26] ibid.

Figure 1 New Zealand Electricity Demand: 2007



Data source: Ministry of Economic Development (2008), New Zealand Energy in Brief, August 2008, p.3.

In general, residential demand is considered less sensitive to income, at least in the short run. Industrial and commercial demand is likely to be more sensitive, depending on the extent to which production is correlated with domestic economic activity. In the longer term, demand will also reflect changes in the energy intensity of industry.

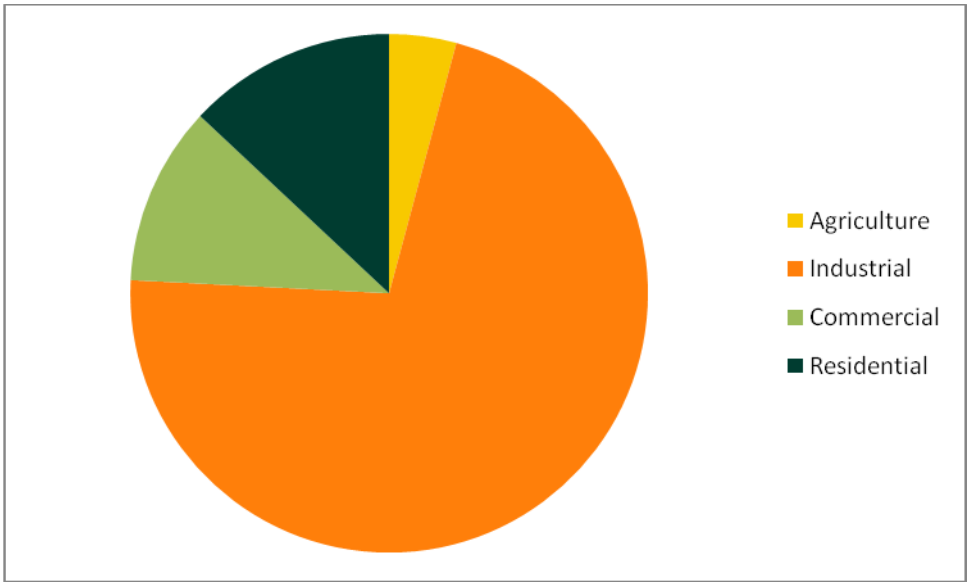
While there are a number of published studies on the price elasticity of demand, there are few studies that have sought to estimate income elasticity. A US study by Branch (1993) found a short-run income elasticity for residential demand of 0.23[27]. We would exercise caution in drawing any definitive conclusions from this estimate, particularly in the context of New Zealand, although we do consider it reasonable to conclude that the income elasticity is positive (but not high).

Gas

The composition of the demand for gas in New Zealand is different to electricity in that industrial customers account for the majority of demand (approximately 72% in 2007). This is shown in Figure 2.

[27] R. Branch (1993), "Short Run Income Elasticity of Demand for Residential Electricity using Consumer Expenditure Survey Data", Energy Journal, Vol.14 (4).

Figure 2 New Zealand Gas Demand: 2007



Data source: Ministry of Economic Development (2008), New Zealand Energy in Brief, August 2008, p.3.

It should be noted that industrial demand includes electricity generation, which Lally notes is sometimes used for baseload rather than variable supply.[28]

At least in terms of demand by residential and small business customers, gas is often considered a 'fuel of choice' relative to baseload alternatives such as electricity. This conclusion was reached by the Queensland Competition Authority, for example, in its 2006 decision in relation to electricity distribution businesses:[29]

> The Authority is of the view that, in many instances, gas is a fuel of choice, while everyone generally connects to electricity. Because it is a fuel of choice, it faces competition from other sources of energy such as electricity and LPG. As such, the Authority accepts that the gas distributors will be subject to a greater level of systematic risk than the electricity distributors and that a higher equity beta is justified.

A similar assessment was also made by the Independent Pricing and Regulatory Tribunal in New South Wales:[30]

[28] M. Lally (2008), op.cit.

[29] Queensland Competition Authority (2006), Final Decision – Revised Access Arrangement for Gas Distribution Networks: Allgas Energy, p.75.

[30] Independent Pricing and Regulatory Tribunal (2000), AGL Gas Network Limited Natural Gas System in New South Wales, July, p.67.

> Gas distribution utilities are regarded as relatively low risk operations. However they are considered to be slightly more risky than electricity distribution utilities as they are considered an energy source of choice.

There are few estimates available of the income elasticity of the demand for gas. An Australian study by Akmal and Stern showed that residential electricity demand is price and income inelastic, whereas residential gas demand has a price elasticity of zero but an income elasticity that is greater than one.[31] Again, we would expect industrial and commercial demand to be more sensitive to changes in income.

Conclusions

Overall, we can conclude that:

- the demand for energy for residential use will be less sensitive to domestic economic activity, with industrial and commercial demand being more sensitive;
- in general, we expect that demand for gas will be more sensitive to changes in income because it is a 'fuel of choice' relative to electricity;
- industrial demand accounts for a relatively higher proportion of the demand for gas compared to electricity.

In his 2008 report, Lally notes the higher utilisation of gas by commercial and industrial users, although he seeks to exclude the effect of demand by the petrochemical industry (because most of this is used in the production of methanol, which is exported, although Lally also observes that given its relatively small revenue contribution the effect on the asset beta is only expected to be small). In relation to this issue, Lally observes that 30% of gas is used by the petrochemical industry. Based on the statistics published by the Ministry of Economic Development, in 2008 around 30% of *industrial* demand is accounted for by this sector, not total demand (it only accounted for around 9% of total gas consumption).[32] Hence, we are of the view that the demand from this sector has been overstated.

In any event, Lally concludes that the beta of a gas business is likely to be higher than electricity:[33]

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[31] M. Akmal and D. Stern (2001), The Structure of Australian Residential Energy Demand, Working Papers in Ecological Economics, The Australian National University, Canberra.

[32] Ministry of Economic Development (2009), Gas Consumption Sectoral Breakdown for 2000 to 2008, http://www.med.govt.nz/templates/MultipageDocumentTOC____41163.aspx.

[33] M. Lally (2008), op.cit., pp.63-64.

> The supply of gas or electricity to commercial and industrial users constitutes an intermediate product whose demand will be driven by the demand for final goods and services. The demand for these final goods and services is likely to be more sensitive to macro economic shocks than the demand for electricity or gas by residential users. So, with gas supply more heavily tilted towards commercial and industrial users than for electricity, the demand for gas is likely to be more sensitive to macro economic shocks. This implies a higher asset beta for the gas pipeline businesses than for the electricity lines businesses.

We concur with this assessment.

6.2.3 Pricing structure

Both electricity and gas tariffs tend to be on a two-part basis, comprising a fixed and variable (throughput-based) component. Based on this structure, Vector's customers tend to have a number of different pricing alternatives to choose from.

There are three main components to the gas transmission tariff. It includes:

- a capacity reservation fee (fixed), which is based on a dollar per gigajoule of reserved capacity per year;
- an overrun fee, for deliveries in excess of the reserved maximum daily quantity; and
- a throughput fee, levied as a dollar per gigajoule on the quantity of gas delivered, based on actual throughput.

It should be noted that the 'fixed' component of gas transmission revenue only comprises dollar per day, dollar per month, or dollar per year charges associated with non-standard contracts.

Of key interest here is how much of Vector's revenues from these activities are fixed and how much are variable. In the short-term, it is the variable proportion that is 'at risk' depending on changes in demand (the extent to which such demand risk might be systematic in nature was considered above). Depending on the extent to which revenues are protected by contracts in the medium to long-term, all of this revenue is at risk.

Vector has provided information on the breakdown of its revenues between fixed and variable (given the point noted above in relation to gas transmission revenues, the split provided below should only be considered indicative).

Table 6 Vector: fixed and variable revenue split

Revenue Source	Auckland electricity distribution	Northern electricity distribution	Auckland gas distribution	Non-Auckland gas distribution	Gas transmission
% fixed	29%	17%	27%	39%	25%
% variable	71%	83%	73%	61%	75%

Source: Vector

This shows that the majority of Vector's revenues from these activities are variable. We assume that this is representative of the industry as a whole (while differences can be expected between firms, we have no reason to believe that there would be any material differences). To the extent that this demand has some systematic component, this increases the systematic risk of an energy network business. This issue also needs to be considered within the context of any further protections provided in its contracts.

6.2.4 Duration of contracts with customers

Vector has some term contracts with its customers although this varies by activity.

The extent to which this provides any further revenue protection depends on:

- the extent to which the contracts increase revenue certainty (for example, via take-or-pay provisions). Overall, however, prices under the contracts tend to be structured as outlined above; and
- the term of those contracts (given it provides some certainty of demand for a set period).

About one-third of Vector's gas transmission revenues are subject to term contracts, with the proportion of contracting in the electricity and gas distribution businesses lower (it is less than 10% for electricity distribution). We understand that most of Vector's contracts tend to be for shorter terms (one to five years).

The existence of these contracts increases Vector's revenue certainty compared to having no contracts in place, primarily for gas transmission revenues (where around 30% of revenues are estimated to be subject to contract). With the exception of Auckland gas distribution, the proportion of revenues subject to contracts for the other activities is not considered material.

Otherwise, prices for most customers tend to be based on their standard terms and conditions, with prices updated annually. As noted above, prices under the contracts continue to have a fixed and variable component. It is also important to note that any revenue protection provided by contracts is only as good as the credit quality of the counterparty to that contract.

6.2.5 Market power

Electricity and gas transmission and distribution network owners naturally possess market power. This is a key reason why these assets are subject to regulation, which significantly constrains the ability of the business to exercise that power to its advantage.

In relation to gas transmission in particular, market power is often tempered by:

- the availability of substitutes for gas as an energy source, including electricity which is likely to remain the most dominant; and
- the significant concentration on the buyer side (via retailers and distributors).

Lally observes:[34]

> In respect of gas pipeline businesses, they seem to be local monopolists but their monopoly power may be diluted by the countervailing power of their large customers and the presence of competing power sources. So, if monopoly power affects beta, then the effect of any such countervailing power and competing energy sources would be to mitigate that beta effect.

Market power tends to have a dampening effect on beta. However, based on the arguments outlined above, this effect is likely to be diluted for gas transmission (and distribution, given the availability of substitutes). Over the longer term, grid-delivered electricity may come under pressure from demand-side alternatives.

6.2.6 Nature of regulation

Vector's systematic risk will be affected by the form of regulation, as this determines its exposure to volume risk. Vector's gas and electricity network businesses are subject to a weighted average price cap form of regulation. This exposes the businesses to greater volume risk compared to rate of return regulation (which generally applies in the US) or revenue cap regulation (which applies in Australia, although some gas distribution businesses have been historically subject to price caps).

Regulated businesses have an opportunity to apply for a Customised Price Path (CPP) to mitigate their exposure to volume risk. However, we understand that given the likely risks and costs of such a process, businesses are unlikely to pursue this unless the volume movements are extreme. The beta analysis needs to be based on the most

[34] M. Lally (2004b), The Weighted Average Cost of Capital for Gas Pipeline Businesses, Report Prepared for the New Zealand Commerce Commission, University of Wellington, p.36.

likely risk profile of the industry 'as is'. Unless there is evidence to show that there is a material probability that CPPs will be sought for a reasonable proportion of demand, it is not considered appropriate to factor this into this analysis. We have therefore not considered this here.

Given price cap regulation exposes the business to higher volume risk, it will lead to a higher beta (all other things being equal). Lally examined this issue in reasonable detail in his 2008 report to the Commission in relation to gas pipeline businesses.[35] In particular, he focused on potential adjustments to data on US comparators that were subject to rate of return regulation. Lally concluded that:

> …the effect of moving from rate of return regulation to five-year price cap regulation would seem to raise the asset beta of electric utilities by about 0.2[36]

In the Commission's 2008 gas authorisation[37], the Commission adjusted the asset beta for form of regulation on the assumption that a four year price cap was being set from 2008, in conjunction with a remedy to reflect the difference between the final 2008 price cap and the provisional price cap applied in 2005. Based on the asset beta differential estimated by Lally, this resulted in a weighted adjustment, with 3/7th assuming a three year price cap and the remaining 4/7th a four year cap. This resulted in an adjustment of 0.13 (compared to the 0.2 adjustment for a five year price cap).

We understand that the expected price path is for five years. Given this, as well as our understanding that Vector's form of regulation will be largely indistinguishable from a pure price cap, it is appropriate to apply Lally's five year price cap adjustment of 0.2.

6.2.7 Growth options

Growth options refer to the potential to undertake significant new investment, particularly in new areas or products. Chung and Charoenwong argue that businesses that have a number of valuable growth opportunities, in addition to their existing assets (or 'assets in place'), will tend to have higher systematic risk compared to firms that don't have these opportunities.[38]

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35 M. Lally (2008), op.cit.

36 ibid., p.61.

37 Commerce Commission (2008), Authorisation for the Control of Supply of Natural Gas Distribution Services by Powerco Limited and Vector Limited, Decisions Paper, 30, October.

38 K. Chung and C. Charoenwong (1991), "Investment Options, Assets in Place and the Risk of Stocks", in Financial Management, Vol.3.

The impact of growth options on beta in a regulatory context is not necessarily clear. If this assessment was based on the analysis of an efficient benchmark firm (that was not regulated), it could be argued that the implications of growth options need to be recognised, regardless of the impact that regulation has on the value of the firm and its risk profile. Alternatively, if the existence of regulation is recognised as part of the assessment, then the presence of growth opportunities may arguably be excluded.

Overall, given the economic conditions and the relatively mature states of the electricity and gas industries in New Zealand and hence the low incremental growth likely to be experienced, we are therefore of the view that growth options are not likely to have a discernible impact on Vector's systematic risk, at least at the current time.

6.2.8 Operating leverage

Like other gas and electricity network businesses, Vector's costs are mainly fixed (we understand that around 90% of the cost base is fixed). High operating leverage is associated with higher systematic risk, as these fixed costs will still be incurred irrespective of actual volumes (and revenues).

As this first principles analysis is being used to determine where Vector would be positioned with respect to a range of beta estimates sourced from comparators, the impact of operating leverage on this decision will depend on Vector's operating leverage relative to these comparators. Unfortunately there is limited data available to enable an assessment of the actual operating leverage of these other firms.

We have no evidence to suggest that Vector's operating leverage is any different than a typical electricity and gas network service provider. The sample we have used in the comparable companies analysis largely comprises gas and electricity firms, which overall, should generally exhibit similar operating leverage unless their operations are more diversified (which is the case with some of the comparators). There may be some differences, for example, gas distribution firms can suffer gas loss, which is essentially a variable cost (transmission firms don't suffer these losses). Given any such losses would depend on the state of the distribution network it is difficult to draw any general conclusions here, and it is possible that the overall impact is marginal.

6.2.9 Conclusions: first principles analysis

The first principles analysis is used to provide context to the equity beta assessment. We have conducted this analysis on the assumption that Vector reflects the typical gas and electricity network business in New Zealand (scaled for size).

In conclusion, what we can observe is that:

- demand for energy is to some extent systematic in nature, given that:
  - residential demand has a positive income elasticity (which in turn, will be positively related to domestic economic growth); and
  - industrial and commercial demand will have some relationship with domestic economic activity, and will be more sensitive to economic growth than residential demand;
- in New Zealand, industrial demand accounts for the highest proportion of electricity and gas demand (accounting for around 72% of the latter in 2007). Residential consumers account for a materially higher proportion of electricity demand at 47% in 2007, compared to only 13% for gas;
- overall, the exposure of a gas business to systematic volume risk is considered higher than electricity, given that:
  - gas tends to be a 'fuel of choice' (for residential and small commercial customers); and
  - a greater proportion of demand tends to be from industrial customers;
- a significant proportion of revenues vary with throughput, while around 90% of its cost base is fixed. This increases its systematic risk;
- there is some protection provided for via contracts, particularly in gas transmission, although revenues still remain exposed to changes in volumes under those contracts (based on the variable component of charges). This protection is limited to the duration of the contracts, which tend to be relatively short (less than five years). Further, it is dependent on the credit quality of the end customer;
- the impact of form of regulation also needs to be considered. Lally has estimated increments that would apply when comparing a price cap with rate of return regulation. It is understood that Vector is likely to be subject to a five year weighted average price cap (that is largely indistinguishable from a pure price cap) ;
- the impact of market power and growth options on beta is not considered to be material here;
- Vector has high operating leverage, which is a significant contributor to systematic risk. However, we have no evidence to suggest that it is different from other comparable businesses, provided their activities are mainly focused in gas or electricity network services; and

- while we can conclude that the systematic risk of a gas network business is likely to be higher than an electricity network business (for the reasons outlined above), we have not identified any differences to warrant distinguishing between transmission and distribution activities.

We can therefore conclude that Vector's electricity and gas transmission distribution businesses are exposed to risk that is systematic in nature. While this first principles assessment is purely qualitative, we can use this to potentially refine any conclusions emerging from the comparable companies analysis, which now follows.

6.3 Comparable companies analysis

6.3.1 Approach applied in this review

There are a number of measures we have implemented here in an attempt to address estimation error.

First, we have constructed estimates for a sample of firms that are considered to be of the most relevance to Vector's electricity and gas networks.

Second, we eliminated any firms that did not have five years of monthly share price data. Unfortunately, Vector had to be excluded on this basis. A summary of the rationale for using monthly data, and not say, weekly, is provided in the following Box.

Box 1 Rationale for the use of monthly observations

Because shares are traded relatively infrequently it is not always possible to obtain a precise measurement of return. If returns could be measured continuously then the return on an individual security (R_{it}) and the return on the market (R_{mt}) would be a perfectly matched pair so that regressions of R_{it} and R_{mt} would give precise beta estimates. Because prices for shares occur and are reported at distinct random intervals an accurate calculation of returns is almost impossible. If correct returns cannot be measured it becomes very difficult to calculate correct betas.

One of the issues that needs to be considered is the interval over which the return on the asset is measured. In many cases trades in a specific share do not occur every day. It follows that the time period or lag over which observations are taken may result in some information being ignored.

This problem does not depend on infrequent trading. Much of the research has focused upon daily information. This research argues that beta estimates, particularly in the short term, vary according to the lag period used to measure the returns.

Research has shown that the 'interval effect' on beta estimation is that as the interval is shortened:

- beta falls for relatively thinly traded securities; and
- beta rises for relatively thickly traded issues of securities.

Cohen, Hawawini, Maier, Schwartz and Whitcomb (1983) and Fung, Schwartz and Whitcomb (1982) have

conducted studies in the United States, France and Australia and they see the true beta is a function of the lag period taken to measure returns and the size of the firm. Both variables (lag and firm size) are seen as indicators of the frequency of trading in a particular security.

There is no reason why non-trading should be confined to one day or week. When daily prices are used it is easy to understand why beta estimates fluctuate. A small fluctuation in price would be quite substantial in terms of day to day changes and day to day estimations. However as the time periods for measuring returns are extended, the expectation is that more stability would enter the measurement and smaller fluctuations occur in beta estimates. With smaller fluctuations R_{it} and R_{mt} should have a stronger relationship. Hence the longer the interval, the stronger is the relationship.

Third, we eliminated any estimates from the sample that had a t-statistic of less than two (see footnote 20 for an explanation of the t-statistic).

The reason we have applied these filters is because regression analysis is a statistical procedure that is commonly used to estimate beta in the absence of being able to observe the 'true' value of that beta. The explanatory power of the resulting estimate is of fundamental importance. If the resulting estimate has relatively low explanatory power, we cannot be confident that the estimate provides any valuable information regarding the true value of that beta.

Adjustments for mean reversion

The Blume adjustment is a statistical technique that is used in recognition of the tendency for betas to mean revert towards unity over time. The adjustment is applied by a number of data providers, such as Bloomberg. Gray et al identify two main reasons why betas may exhibit mean reversion:

- it reflects a conscious decision by management to move the firm towards the average risk of the market (via its investment strategies); **or**
- beta *estimates* might revert towards unity even if the 'true' beta is stable:

> That is, Blume-type adjustments can be interpreted in the context of measurement error rather than any conscious decision undertaken to move the firm's true beta toward unity.[39]

Regulators have tended to reject the application of the Blume adjustment based on the first reason. However, this ignores the fact that mean reversion may have nothing to do with actual management practice and could actually be due to the second reason, and hence may be a source of measurement error that in turn could result in regulatory error. There is no evidence confirming why the second reason should be rejected in

[39] S. Gray, J. Hall, R. Bowman, T. Brailsford, R. Faff, and R. Officer (2005), op.cit., p.10.

favour of the first. In the absence of such evidence we are of the view that a conservative approach would be to consider a number of possible adjustments for measurement error that could improve the quality of the comparator estimates.

The Vasicek adjustment is another technique that is used. It is similar to the Blume adjustment as it calculates a beta as a weighted average of the beta estimate produced by the regression based on a 'prior belief' beta estimate (which may or may not be 1). That is:

$$\beta_{vasicek} = \frac{\sigma^2_{market}}{\sigma^2_{market} + \sigma^2_{OLS}} x\beta_{OLS} + \left(1 - \frac{\sigma^2_{market}}{\sigma^2_{market} + \sigma^2_{OLS}}\right) x\beta_{priorbelief}$$

This methodology hinges on the assumption regarding the 'prior belief', as this is the mean value that beta is assumed to revert too. When this issue has been considered in the context of electricity determinations in Australia, for example, a value of one has often been applied because: (1) this was the equity beta value that was most commonly determined for regulated electricity businesses (prior to the AER's most recent decision); and (2) an equity beta based on the distribution of all betas in the market is considered a reasonable starting point, particularly in the absence of any robust evidence of a 'prior belief' value other than one. SFG Consulting states:[40]

> Suppose a practitioner was asked to estimate the beta of a company, with no company- or industry-specific information. By construction, the market capitalisation weighted average beta of all companies in the market is one. By making an estimate of one, there is an equal probability that the practitioner has over- or under-estimated systematic risk. Next, the practitioner performs an OLS regression of stock returns against market returns, without any additional company- or industry-specific information, and is able to refine the original estimate. The Vasicek bias correction applies weight to the OLS beta estimate on the basis of its precision, and some weight on the prior estimate of one.

We consider a prior belief of one to be an appropriate starting point here. This also provides consistency with the assumption of the Blume adjustment.

We note that the Expert Panel did not reach a consensus view on this issue. Dr Lally was opposed to using the Blume (or Vasicek) adjustments. Professors Myers and Franks, on the other hand, gave more recognition to the issue of mean reversion, recommending that some form of Bayesian adjustment is applied.

[40] SFG Consulting (2008), The Reliability of Empirical Beta Estimates: Report Prepared for the ENA, APIA and Grid Australia, September, paragraph 81.

We have therefore provided our comparator beta estimates in raw form (that is, no adjustment for mean reversion), with the Blume adjustment and with the Vasicek adjustment (assuming a prior belief of one).

6.3.2 Selecting the comparator sample

We have examined two sectors in our analysis, being:

- gas utilities; and
- electric utilities.

In compiling the sample, we applied a number of filters with two key aims, being to ensure that:

- the business activities of the firm are sufficiently relevant to our purpose, placing emphasis on firms involved in gas and/or electricity transmission and distribution; and
- the sample was statistically robust, given the issues with estimation error that were outlined above. Despite the filters being applied here, estimation error will remain an issue and needs to be kept in mind when drawing any conclusions from the analysis.

The filters applied were as follows:

- at least five years of monthly data is necessary for each firm. We applied a minimum threshold of 60 observations; and
- beta estimates with a t-statistic of less than 2 were excluded (refer footnote 20).

The most relevant comparators will be New Zealand firms although as has already been widely recognised, there are insufficient firms to limit our analysis to this market. This has similarly proven an issue in Australia, where there is also a relatively small number of firms that meet these requirements. In particular, given mergers and divestments that have occurred in the industry, there are difficulties finding firms for whom 60 months of data can be collected.

Significant caution should also be exercised in relying upon foreign comparators, and preference should be given to those jurisdictions that have (at least broadly) similar economic, commercial and regulatory structures. For this reason, we have limited our overseas jurisdictions to Australia, Canada, the United Kingdom and the United States. Unfortunately, none of the UK firms survived our filters. However, further

adjustments may need to be made, particularly for the US firms, which dominate our sample.

The company data was sourced from Bloomberg, based on those businesses that are classified as either "Gas Utilities" (sub-industry category 55102010) or "Electric Utilities" (sub-industry category 55101010), based on the Global Industry Classification Standard (GICS). The classification of companies into these categories is done by Standard & Poor's and MSCI Barra, according to the definition of the principal business activity as determined by the two companies.[41] Revenue is a key means of determining this, however earnings analysis and market perceptions are also considered.

Each of these sectors includes businesses engaged in transmission, distribution, generation, retail, marketing and a number of other energy-related services. Companies may also be involved in other activities, such as telecommunications or construction. We therefore examined the descriptions provided and identified those firms that were engaged in transmission and/or distribution.

This revealed two broad groups of firms, being:

- firms that appear to be primarily engaged in transmission and/or distribution; and
- more integrated energy utilities, which are engaged in transmission and/or distribution as well as other activities.

We have included the second group of firms given the relatively small number of firms that are primarily engaged in transmission and/or distribution that survived our statistical filters. However, given they are involved in other activities (albeit energy-related), they are of less relevance to our purpose.

Following our initial analysis we further examined the activities of the more relevant firms. Where possible, we sought to obtain data on the proportion of their business that was engaged in transmission and/or distribution (primarily via revenues). This data was available for some firms, but not others.

In terms of the gas utilities, the firms that appear to be more heavily engaged in transmission and/or distribution include:

- APA and Envestra (Australia), noting that both of these firms have reasonably large portfolios of gas network assets that are diversified across geographic regions (and customer bases);

41 Standard & Poor's (2008), Global Industry Classification Standard, August.

- Pacific Northern (Canada); and
- Atmos Energy (US).

There are only two electric utilities that survived our statistical filters that are heavily engaged in transmission and/or distribution, being Exelon and Pepco. However, upon closer examination it is not possible for us to conclude that the majority of their revenues are sourced from these activities (with both firms engaged in other activities, albeit energy related). We therefore consider that it will be difficult to make an informed assessment of the betas of an electricity transmission/distribution business from a sample of two comparators, particularly when the influence of their other activities on their betas remains unclear.

Full details of our sample are provided in Appendix A. All data was sourced from Bloomberg.

We delevered the observed equity betas using the average gearing for each firm over the same five year period. We applied the formula recommended by the Commission, which is:

$$\beta_a = \beta_d\left[\frac{D}{D+E}\right] + \beta_e\left[\frac{E}{E+D}\right]$$

Because we have assumed a debt beta of zero, the first term of this equation drops out.

6.3.3 Results

There are fourteen businesses in our sample of gas utilities. The results are summarised in the following table. Again, we have separated those firms that are predominantly involved in transmission and/or distribution, from the more integrated firms.

Table 7 Betas for gas utilities

Company	Equity beta	Standard error	t-stat	R^2	Average debt to value	Asset beta (Raw)	Asset beta (Blume-adjusted)	Asset beta (Vasicek adjusted)
Mainly transmission and distribution								
Australia								
APA Group	0.751	0.189	3.968	0.214	58.7%	0.310	0.344	0.350
Envestra Limited	0.865	0.259	3.333	0.161	78.9%	0.182	0.192	0.198
Canada								
Gaz Metro Limited Partnership	0.396	0.132	2.987	0.133	53.4%	0.184	0.278	0.250

Company	Equity beta	Standard error	t-stat	R^2	Average debt to value	Asset beta (Raw)	Asset beta (Blume-adjusted)	Asset beta (Vasicek adjusted)
Pacific Northern Gas	0.412	0.133	3.094	0.142	39.3%	0.250	0.368	0.333
US								
AGL Resources Inc	0.395	0.118	3.355	0.163	35.5%	0.255	0.383	0.330
Atmos Energy Corporation	0.505	0.105	4.795	0.284	38.7%	0.310	0.410	0.358
Southwest Gas Corporation	0.727	0.143	5.097	0.309	41.2%	0.427	0.480	0.469
Chesapeake Utilities Corporation	0.462	0.145	3.184	0.149	32.0%	0.314	0.435	0.411
Other integrated gas utilities								
National Fuel Gas Company (US)	0.727	0.151	4.819	0.286	29.5%	0.513	0.576	0.567
EQT Corporation	0.826	0.192	4.306	0.242	30.2%	0.577	0.617	0.624
Energen Corporation (US)	1.198	0.193	6.201	0.399	26.6%	0.879	0.832	0.822
UGI Corporation (US)	0.352	0.137	2.566	0.102	40.6%	0.209	0.336	0.304
Ferrellgas Partners (US)	0.648	0.142	4.555	0.263	70.2%	0.193	0.227	0.220
Delta Natural Gas Company	0.471	0.110	4.261	0.238	40.9%	0.278	0.381	0.333

Source: Bloomberg

Of the firms involved primarily in distribution or transmission, we can observe:

- for the US firms, the range is between 0.255 to 0.427 (0.383 to 0.48 Blume-adjusted and 0.33 to 0.47 Vasicek-adjusted). The average (simple) is 0.326 (0.418 Blume-adjusted and 0.4 Vasicek-adjusted) and the standard deviation is 0.041;
- there is considerable variability amongst our small sample of Australian and Canadian firms.

If we refine this sample to the four comparators outlined above (noting the issues with a reduced sample size), the raw betas range from between 0.18 and 0.31 (APA and Atmos Energy). If we adjust for mean reversion, the range is between 0.19 and 0.41 (Blume) and 0.2 and 0.36 (Vasicek). At the same time, caution must be exercised in making comparisons given these four firms are sourced from three different jurisdictions.

Considerable variability is also exhibited within our sample of integrated utilities, with asset betas ranging between 0.193 (0.227 Blume-adjusted, 0.22 Vasicek-adjusted) to 0.879 (0.832 Blume-adjusted, 0.822 Vasicek-adjusted). This could also reflect the diverse activities of the firms. The simple average is 0.442 (0.495 Blume-adjusted, 0.478 Vasicek-adjusted) with a standard deviation of 0.22. We need to be particularly

cautious in interpreting these results as it reflects the risks of other activities, such as generation.

The results from our sample of electric utilities are provided in Table 8.

Table 8 Betas for electric utilities

Company	Equity beta	Standard error	t-stat	R^2	Average debt to value	Asset beta (Raw)	Asset beta (Blume-adjusted)	Asset beta (Vasicek-adjusted)
Mainly transmission and distribution (all US)								
Exelon Corporation	0.629	0.147	4.283	0.24	30.4%	0.438	0.523	0.58
Pepco Holdings Inc	0.577	0.154	3.758	0.195	38.8%	0.353	0.439	0.502
Other integrated electric utilities								
US								
FPL Group	0.636	0.129	4.933	0.296	34.6%	0.416	0.494	0.531
Duke Energy Corporation	0.437	0.107	4.101	0.225	28.7%	0.312	0.444	0.469
Entergy Corporation	0.673	0.141	4.760	0.281	30.9%	0.465	0.540	0.585
American Electric Power Company	0.571	0.123	4.635	0.270	36.9%	0.361	0.450	0.486
FirstEnergy Corp	0.550	0.173	3.178	0.148	37.1%	0.346	0.439	0.524
Allegheny Energy	0.995	0.209	4.752	0.280	45.1%	0.546	0.547	0.548
Northeast Utilities	0.501	0.133	3.761	0.196	38.1%	0.310	0.412	0.465
DPL Inc	0.579	0.120	4.837	0.287	46.6%	0.309	0.383	0.41
NV Energy Inc	0.787	0.167	4.719	0.277	48.1%	0.409	0.445	0.476
Westar Energy	0.663	0.121	5.481	0.341	33.5%	0.441	0.515	0.543
Great Plains Energy Incorporated	0.810	0.123	6.603	0.429	33.5%	0.539	0.581	0.597
Cleco Corporation	0.537	0.126	4.277	0.240	31.7%	0.367	0.471	0.516
Idacorp Inc	0.432	0.141	3.065	0.139	34.5%	0.283	0.406	0.48
Allete Inc	0.742	0.141	5.260	0.323	26.9%	0.542	0.604	0.642
Unisource Energy Corporation	0.601	0.201	2.987	0.133	58.7%	0.248	0.302	0.363
UIL Holdings Corporation	0.731	0.160	4.582	0.266	31.3%	0.502	0.563	0.611
El Paso Electric Company	0.694	0.135	5.152	0.314	37.9%	0.431	0.494	0.527
The Empire District Electric Company	0.790	0.128	6.158	0.395	40.4%	0.471	0.513	0.532
Central Vermont Public Service Corporation	0.674	0.255	2.640	0.107	28.5%	0.482	0.559	0.666
New Zealand								
TrustPower Limited	0.760	0.133	5.727	0.361	26.5%	0.559	0.617	0.646

Source: Bloomberg

There is only one non-US firm in the sample, TrustPower Limited, whose activities are of less relevance for this purpose because it has generation and retail activities. Of the two most useful firms, the asset betas are 0.353 (0.439 Blume-adjusted, 0.5 Vasicek-adjusted) and 0.438 (0.523 Blume-adjusted, 0.58 Vasicek-adjusted). Of our remaining integrated US utilities, the asset betas range from 0.283 (0.406 Blume-adjusted, 0.48 Vasicek-adjusted) to 0.546 (0.547 Blume-adjusted, 0.548 Vasicek-adjusted). The simple average of the asset betas is 0.41 (0.482 Blume-adjusted, 0.525 Vasicek-adjusted), with a standard deviation of 0.09.

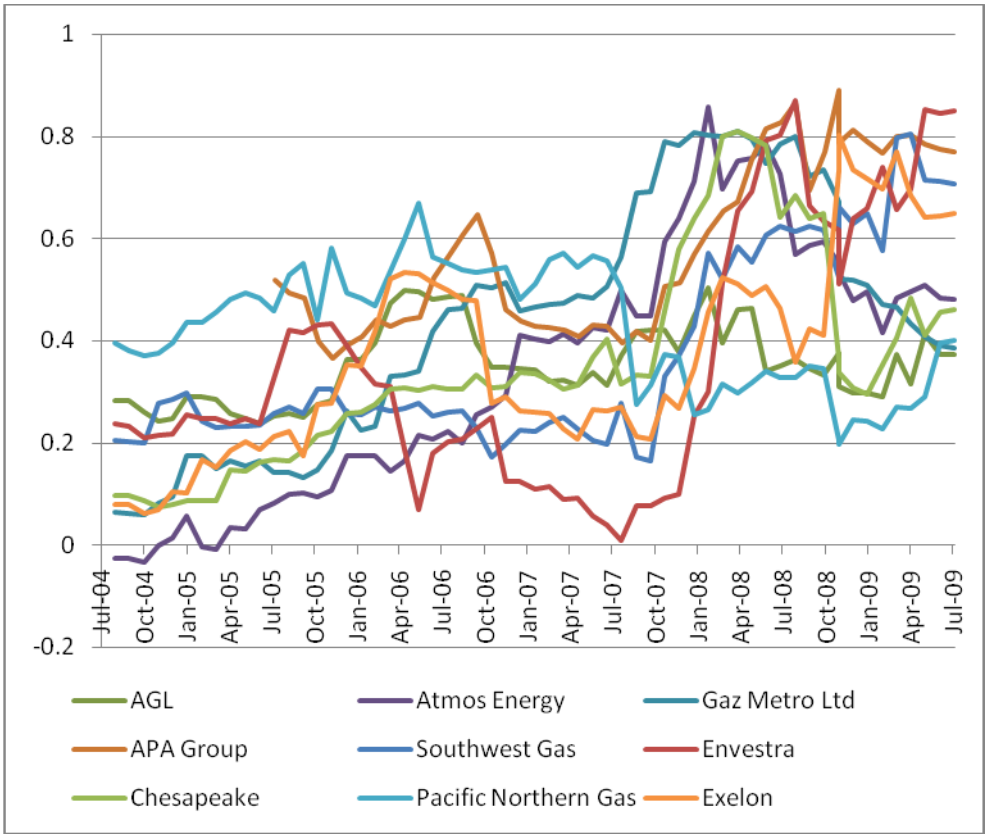
6.3.4 Rolling betas

The Commission noted that betas can be volatile through time, and hence proposes to check beta estimates "with monthly data over long periods using a plot of rolling five-year betas."[42] We have undertaken this analysis for the firms in our sample that are mainly engaged in transmission or distribution.

The betas are calculated using 60 months of data. The first beta is calculated for the five years ending July 2004 (which means that the returns underpinning that estimate go back to July 1999). A beta is then calculated each subsequent month for the five years ending that month. As not all of our firms had share price data back to July 1999, we could not calculate a rolling beta for all firms between July 2004 and July 2009. The results are shown in the figure below.

[42] Commerce Commission (2009), op.cit., para. 173.

Figure 3 Rolling 5 year equity betas: firms mainly involved in transmission and/or distribution

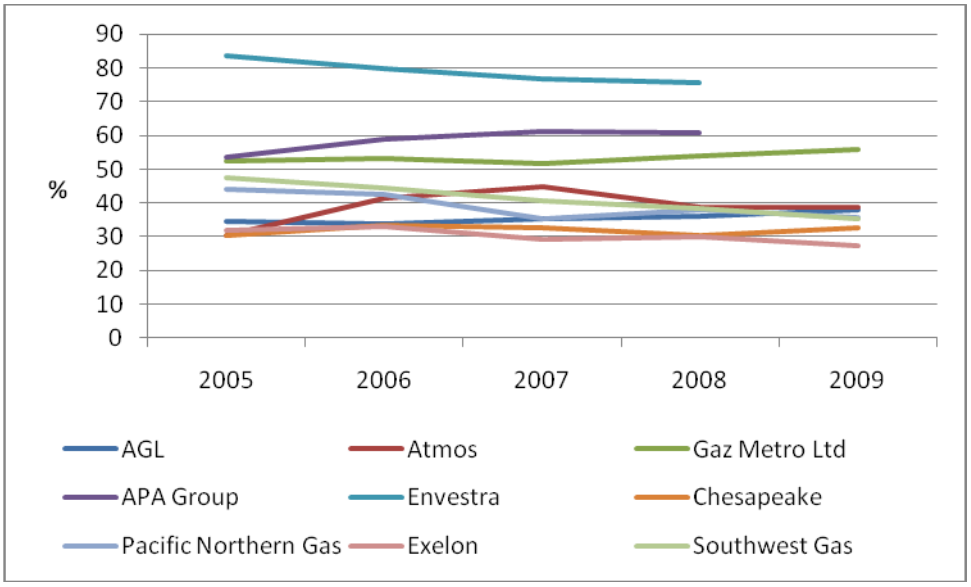


Data source: Bloomberg

This clearly shows that betas have gradually increased through time. It is possible that they will continue to increase through time. However, we need to be cautious in drawing any definitive conclusions from this data in relation to the forward-looking beta.

Further, these betas are equity betas, not asset betas. It is therefore possible that changes in gearing will also be influencing the changes in the equity betas. If a change in gearing is the key driver of the general increase in equity betas, gearing levels would also have had to increase through time. We have therefore looked at the year by year gearing levels for each firm over the last five years, which was used to produce the current beta estimates (2009 data could not be sourced from all firms). This is shown in the following figure.

Figure 4 Debt to total capital: firms mainly involved in transmission and/or distribution



Data source: Bloomberg

This shows that for some firms, gearing has remained relatively constant. A number of firms have reduced their gearing over this time period.

Overall, we are confident we can conclude that the gradual upward trend in equity betas provides no justification for adjusting beta downwards, and to do so would risk under-stating the forward-looking beta estimate.

6.4 Conclusions

It is difficult to draw firm conclusions from the preceding samples. First, there are only a relatively small number of firms that might be considered appropriate comparators for this purpose. Second, we need to take account of jurisdictional differences. Lally considers the differences between US and New Zealand firms in his 2008 report.[43] One of the differences he considered was leverage and tax. Overall, he found that the tax and leverage differences (coincidentally) net out.

Lally considered a number of other data sources in his review, including estimates produced by Damodaran, Alexander et al (1996), Ibbotson Associates and Standard and Poor's. Overall, he assessed an asset beta of 0.3 for US electricity utilities and gas distribution firms. Lally concluded that 0.3 was a lower bound given the rate of return regulation that is applied in the US. He added an increment of 0.2 to reflect the

[43] M.Lally (2008), op.cit.

differences in the regulatory environments between the rate of return regulation applied in the US and a five year price cap.

Lally's base estimate of 0.3 is slightly lower than what our findings suggest, particularly if the Blume and Vasicek adjustments are taken into account. However, we agree that there are difficulties in basing the preferred beta estimate on the mean-adjusted evidence (as opposed to the raw beta), given the adjusted betas effectively assume that the betas will mean revert to the market average of one through time. While we are of the view that betas are likely to mean revert to some long-term average for that industry through time, we do not necessarily know what that average is (and if we were confident in such knowledge, that long-term average would be our preferred estimate).

Further, notwithstanding the statistical filters we applied, the standard errors of the individual estimates remind us that it remains probable that a beta could be observed above or below these estimates. However, given the size and quality of our sample, it is difficult to draw any definitive conclusions on this.

The results of our beta analysis showed that on average, the betas of electric utilities where higher than gas. However, we do not consider it appropriate to draw any inferences from this, particularly given that most of the electricity utilities are more integrated, and are engaged in a range of activities other than transmission and distribution (such as generation and retail). As we would expect that the systematic risk of these other activities is likely to be higher than a stand-alone electricity transmission and distribution business, this could lead to a higher beta (depending on the contribution of each activity to total revenues).

As we concluded in the first principles analysis, we consider it reasonable to assume that the beta of a gas pipeline business is higher than an electricity network business (this is the regulatory treatment that has largely been reflected in Australian regulatory decisions, for example). As outlined above, the key reasons for this are because gas tends to be considered a 'fuel of choice' relative to electricity (at least in relation to residential and smaller commercial demand), it tends to have a higher proportion of industrial and commercial customers, whose demand is more sensitive to domestic economic activity.

Lally reached similar conclusions in his analysis. The key reasons that he saw gas utilities as having higher risks are:[44]

- the presence of more growth options;

[44] ibid.

- the high income elasticity of demand;
- a reasonable proportion of its usage is for variable rather than base supply; and
- a relatively higher proportion of its demand is accounted for by commercial and industrial users.

Lally adds a further increment of 0.1 to account for these differences. He does not consider that there are sufficient differences to warrant a different beta for transmission versus distribution.

As noted above, Lally also proposed an adjustment of 0.2 to reflect the difference between rate of return regulation and a five year price cap. This was 'scaled back' in the Commission's recent gas authorisation on the assumption of a hybrid three and four year price cap.

The first main observation we would make in relation to these estimates is that Lally's conclusions are based on reviewing a range of asset beta estimates for US utilities from a variety of sources and over different time periods. Most of these estimates pre-date our analysis (the sample periods range from 1989 to 1993 through to 2002 to 2007). Given our rolling beta estimates show in Figure 3 suggest that betas have increased over the course of this decade, looking at Lally's sample periods does not enable us to conclude that this effect would be reflected in his proposed estimates (it is also not clear why they may have increased through time).

Unfortunately, however, there is insufficient evidence from our analysis to make any firm conclusions on the current parameter estimates. While the AER's recent review of the betas of electricity transmission and distribution businesses primarily referenced Australian firms, similar observations were made in relation to the quality of the data relied upon. In relation to the AER's sample SFG Consulting concluded:

> In summary, it is difficult to imagine any set of estimates faring worse on these "key objective criteria." In my view, this indicates that the data that is required to produce reliable estimates simply does not exist. The estimates that have been produced are neither plausible nor economically reasonable and should not be afforded material weight.[45]

Apart from the need to demonstrate that an alternative value is materially better than the parameters that have been previously estimated by Lally and applied by the Commission, we remain conscious of the inherent uncertainty in estimating beta and

[45] SFG Consulting (2009), The Reliability of Empirical Beta Estimates: Response to AER Proposed Revision of WACC Parameters, Draft Report Prepared for ENA, APIA and Grid Australia, 28 January, p.17.

the risk of error. Reference is also made to our rolling beta analysis, which enables us to conclude that any further reductions in beta would significantly increase the risk that beta is materially under-stated (given they may have actually increased relative to Lally's sample periods).

Our second observation is that it is unnecessary to scale back Lally's 0.2 adjustment to reflect the difference between rate of return regulation and a five year price cap. It is understood that this is the term that is being contemplated for Vector and its risk profile is effectively equivalent to a pure price cap.

In our view, starting from an asset beta of 0.3 for the US, and based on:

- the conclusions from our first principles analysis;
- the limited data that we are able to reference; and
- the rolling beta analysis,

an asset beta of 0.5 for electricity and 0.6 for gas is considered reasonable for Vector.

7 Market Risk Premium

7.1 Commerce Commission's Position in Draft Guidelines

The estimation of the market risk premium (MRP) has proven reasonably contentious in regulatory determinations. The MRP is the amount an investor expects to earn from a diversified portfolio of investments over and above the return earned on a risk-free investment. The key difficulty in estimating the MRP arises from it being an expectation and therefore not directly observable.

> The equity premium is not only the single most important number of finance, but estimating it is also our most perplexing problem.[46]

Given the number of issues surrounding the estimation of the MRP and the debate that has occurred in previous regulatory decisions, we found it particularly surprising that relatively little attention was given to this issue by both the Expert Panel and the Commission. We consider it important that this issue is given a thorough review.

There are a number of methods that have been used to estimate the MRP. The most common approach is to apply a long-term historical average of the excess returns from holding shares (based on the return on the relevant sharemarket index) compared to the risk-free rate. Overall, we concur with the Commission that historical techniques are the most useful starting point for the analysis. We note that the Commission recommends the use of Dimson et al (2008) estimates, adjusted for long-term trends in price-dividend ratios. It then recommends using forward-looking estimates as a cross-check. Judgement is unavoidably applied to arrive at a recommended estimate.

We note that there was consensus amongst the Expert Panel on some, but not all, of the issues that they examined (which, as we outlined above, were extremely limited). The panel members agreed that the Commission should:[47]

- continue to draw on international estimates; and
- retain its approach of considering forward-looking and historical estimates.

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[46] I. Welch (2000), Research Roundtable Discussion: The Market Risk Premium, p.3, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=234713.

[47] J. Franks, M. Lally & S. Myers (2009), Recommendations to the New Zealand Commerce Commission on an Appropriate Cost of Capital Methodology, p.22.

However, there was a difference of opinion in the relative weight that should be applied to forward-looking and historical estimates, with Franks and Myers recommending that primary weight be placed on historical estimates and Lally favouring equal weights over a wide range of estimation methods.

In this section we will first consider an appropriate historical estimate for the MRP. We will then examine this estimate within the context of forward-looking estimates, with particular focus on the implications of the global financial crisis for the MRP.

7.2 Estimation method

There are a number of issues that need to be considered here, including:

- benchmarking approach;
- data source;
- length of the estimation period;
- geometric versus arithmetic averages; and
- term of the risk-free rate.

Each of these issues is considered below.

7.2.1 Benchmarking approach

We support the Commission's recognition of the benchmarking approach to estimating the MRP. The approach is well supported in the literature.

Perhaps the best known book on valuation is published by McKinsey and Company.[48] They recommend using a worldwide MRP, which they regard as equivalent to the US MRP, and then adjusting that upward for differences in size for the country.

UBS Investment Bank released a report on estimating WACC.[49] It commented on the MRP in the US and on an appropriate approach to estimating MRP in other markets.

> Yet under the forces of globalism and capital market convergence, many experts now suggest that increasingly the US market may serve as the best proxy for a

[48] McKinsey & Company, Inc (T. Copeland, T. Koller and J. Murrin) (2000), Valuation: Measuring and Managing the Value of Companies (3rd ed), John Wiley & Sons, New York, pp 370-375.

[49] UBS Investment Bank (2005), The WACC User's Guide, March, p.5.

> future global market risk premium. The US has the largest economy and the most liquid capital markets. Consequently, the 5% risk premium seems appropriate for other markets, after adjusting for differences in tax rates, etc.

Professor Damodaran, a prominent academic and textbook author, uses a similar benchmarking approach, which can be seen in a paper available on his website titled "Country Default Spreads and Risk Premiums".[50]

The approach of using a benchmark of either a US or world MRP and then adjusting for factors such as size and taxes to estimate the MRP for a country, is well recognised and accepted.

Using the benchmark approach, New Zealand's MRP can be thought of as being equal to an international benchmark MRP plus a premium for the incremental risks associated with the New Zealand equity market.[51] Applying the benchmarking approach to estimating a MRP for New Zealand requires first choosing the benchmark, estimating the MRP for that benchmark, and then estimating the appropriate adjustment to the MRP of the benchmark country to arrive at an estimate for New Zealand.

Choice of a benchmark MRP

As to the choice of the best benchmark, the US is suggested in the quotations and is the compelling choice.

Contrary to the situation in New Zealand, the US has been an open economy for virtually all of its existence. The quantum of evidence and analysis of the US equities markets (and its MRP) would probably exceed that of all other countries in the world combined. The historical evidence is as good as is available for any country in the world. Therefore, the US would be widely regarded as the appropriate benchmark against which to measure risk premiums.

Having determined that the US is the appropriate benchmark country, it is next necessary to estimate the MRP for the US.

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[50] http://pages.stern.nyu.edu/~adamodar/

[51] See R. Bowman ("Estimating the Market Risk Premium," *JASSA*, issue 3, Spring 2001, pp 10-13) for a thorough coverage of this approach to estimating the MRP.

7.2.2 Data source

The Commission has recommended the use of estimates produced by Dimson, Marsh and Staunton. We have referred to a comprehensive study they undertook in 2006, which developed estimates of the equity risk premium for 17 countries and then considered the results within the context of the 'equity premium puzzle', which has underpinned concerns by the Commission (and others) that observed historical equity risk premia may be overstated.[52]

The study uses the DMS global database, which:[53]

> …comprises annual returns, and is based on the best quality capital appreciation and income series available for each country, drawing on previous studies and other sources. Where possible, data were taken from peer-reviewed academic papers, or highly rated professional studies.

In particular, one of the 'guiding principles' for their study was to:[54]

> …avoid survivorship, success, look-ahead, or any other form of *ex post* selection bias…

although they do acknowledge that the database still suffers from survivorship bias because all 17 countries have a full 106 year data history.

Length of the estimation period

There are a number of questions that need to be considered before we consider their results. The first is the length of the estimation period. One school of thought proposes that as long a horizon as possible should be used. This is because from year to year, the MRP is extremely volatile and a longer term average is required to produce a meaningful estimate. This assumes that investors' risk aversion has not changed over time and the *ex ante* market risk premium has remained stable.

An alternative view is that only more recent data is relevant, particularly if the market has undergone significant structural change over time (for example, the introduction of dividend imputation). This approach results in an estimation problem in that estimates based on shorter datasets have standard errors that are too high to produce a

[52] E. Dimson, P. Marsh & M. Staunton (2006), "The Worldwide Equity Premium: A Smaller Puzzle", London Business School, 7 April.

[53] ibid., p.8.

[54] ibid., p.10.

statistically meaningful estimate.[55] Further, conditions prevailing over a short period of time may not necessarily be an appropriate basis for a forecast (for example, unusually high returns or high volatility).

Dimson et al have produced estimates over a 106 year period between 1900 and 2005. In using such a long time period, they examined year on year estimates, as well as estimates for key sub-periods through time, including the impact of significant world events. This confirmed the inherent volatility of shorter term estimates. They conclude that:[56]

> When estimating the historical equity premium, therefore, the case for using long-run data is clear. Stock returns are so volatile that it is hard to measure the mean historical premium with precision. Without long-run data, the task is impossible, and even with over a century of data, the standard error remains high – even if we assume that the underlying series is stationary.

We concur with the use of a long-term estimate as a proxy of the forward-looking MRP. The only circumstance under which this might be questioned is where there has been a structural change, which has altered the way in which investors assess risk and return. This is considered at the end of this section.

Geometric versus arithmetic averages

Dimson et al report both geometric and arithmetic averages. As there is a material difference between the estimates under each approach, a decision must be made as to which is the most appropriate to use for this purpose.

Arithmetic averages are more popular but arguments are made in the literature for geometric averages on the basis that they are more efficient (that is, they will produce less biased estimates of the "true average"). A study by Hathaway noted significant differences between averages under each method, with the arithmetic mean producing an estimate of 7.2%, whereas the geometric mean estimate was 6%.[57] Hathaway opined that the geometric return is more appropriate for historical averaging, but the arithmetic average is appropriate for future estimates as it provides an unbiased estimator of expected future outcomes.

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[55] A. Marsden and M. Lally (2004), ("Historical Tax-adjusted market risk premiums in New Zealand: 1931-2002",*Pacific Basin Finance Journal, p.*423 – 449) report standard deviation of annual returns of over 23% for historical market risk premiums.

[56] ibid., p.16.

[57] N. Hathaway (2005), Australian Market Risk Premium, Capital Research Pty Ltd.

Gray and Officer also support the use of an arithmetic mean.[58] They state that the arithmetic mean is the preferred method on the basis that we are looking to estimate the expected value of the MRP. They note that a geometric mean is appropriate:[59]

> …when estimating the aggregated return from a buy and hold strategy over a long period, but that is not the purpose here. The MRP is to be used in the CAPM to compute the cost of equity expressed in annual terms. Therefore, we require an estimate of the expected return, over the next year, on the market portfolio over and above the risk-free rate. What return do we expect on the market portfolio over the next year, relative to the risk-free rate? The historical data provides us with many observations on what the market returned relative to the risk-free rate over a one-year period. To the extent that each of these observations should be given equal weight, a simple arithmetic average is appropriate.

We are of the view that an arithmetic average is the most appropriate method for estimating the MRP based on historical data. The CAPM is a single time horizon model and as such the use of a geometric average would be inconsistent with its assumptions.

Estimates

The estimates produced by Dimson et al are summarised in the following table.

[58] S. Gray & R. Officer (2005), A Review of the Market Risk Premium and Commentary on Two Recent Papers, A Report Prepared for the Energy Networks Association, p.21.

[59] ibid.

Table 9 Annualised equity premiums 1900 - 2005

Country	Arithmetic Average	Standard Error	Standard Deviation
Australia	7.81	1.83	18.80
Belgium	4.37	1.95	20.10
Canada	5.67	1.74	17.95
Denmark	3.27	1.57	16.18
France	6.03	2.16	22.29
Germany[a]	8.35	2.69	27.41
Ireland	5.18	1.78	18.37
Italy	7.68	2.89	29.73
Japan	9.98	3.21	33.06
Netherlands	5.95	2.10	21.63
Norway	5.26	2.66	27.43
South Africa	7.03	1.88	19.32
Spain	4.21	1.96	20.20
Sweden	7.51	2.17	22.34
Switzerland	3.28	1.70	17.52
UK	5.29	1.61	16.60
US	6.49	1.96	20.16
Average	6.08	2.11	21.71
World – ex US	5.18	1.48	15.19
World	5.15	1.45	14.96

a Germany omits 1922-23

Source: E. Dimson, P. Marsh & M. Staunton (2006), "The Worldwide Equity Premium: A Smaller Puzzle", London Business School, 7 April, p.18.

The long-term historical average US MRP is 6.5%. While the authors express some caution in interpreting the US estimate because of 'ex post success bias' (which is some 1.31% higher than the 'world' estimate, excluding the US), they also observe that the US still ranked only seventh out of the 17 countries based on the arithmetic mean. After considering the issue of survivorship bias in some detail, they conclude that:

> …provided a very long run approach is taken, inferences from the United States do not appear to have given rise to very large overestimates of the historical world equity premium. It is still possible, however, that our world index overstates worldwide historical equity returns by omitting countries that failed to survive.[60]

We have also examined the recent literature for alternative estimates of the US MRP. Damodaran (2008) examines historical estimates over a range of periods, the implied

[60] ibid., p.21.

premium (based on discounted cashflow analysis) and survey evidence (he examined surveys by Campbell and Harvey and Merrill Lynch, both of which were conducted in 2008).[61] These findings are summarised in Table 10.

Table 10 Damodaran (2008): US MRP estimates

Method	Estimate
Historical arithmetic average: 1928- 2007	6.42%
Historical arithmetic average: 1967 – 2007	4.33%
Historical arithmetic average: 1997 – 2007	2.68%
Current implied premium	4.54%
Average implied premium: 1960-2007	3.98%
Surveys	3.8%

Source: A.Damodaran (2008), Equity Risk Premiums (ERP): Determinants, Estimation and Implications, http://pages.stern.nyu.edu/~adamodar/.

Campbell (2007) estimates the US MRP by estimating the conditional geometric average stock return and then subtracting the real interest rate.[62] This is then converted to an arithmetic average MRP. A return forecast is constructed using different assumptions regarding firm profitability and dividend payouts.

The geometric average estimates of the US MRP are as follows:

- 3.2%, assuming constant profitability and payouts;
- 6.9%, assuming recent profitability and payouts; and
- 4.1%, assuming profitability and payouts based on 75% long-term average and 25% recent data.

Goetzmann and Ibbotson (2005) propose that the historical estimated MRP will be more accurate the longer the data series, provided fundamental expectations remain the same.[63] They compare their estimate from 1926 to 2004 to the period 1792 to 1926. The estimated MRP (arithmetic average) between 1792 and 1926 was 3.76%. The MRP for the subsequent period was 6.57%.

[61] A.Damodaran (2008), Equity Risk Premiums (ERP): Determinants, Estimation and Implications, http://pages.stern.nyu.edu/~adamodar/

[62] J. Campbell (2007), Estimating the Equity Risk Premium, Working Paper 13423, NBER Working Paper Series, September.

[63] W. Goetzmann & R. Ibbotson (2005), "History and the Equity Risk Premium", Yale ICF Working Paper No. 05-04, April.

Term of the risk-free rate

A further issue that needs to be considered is the maturity of the risk-free rate that underpins the MRP estimate, recognising that estimates that reference bond rates are typically based on long maturities. Dimson et al note that their US estimates are based on the ten to fifteen year bond index. The Australian estimates use a five year bond rate to 1949, and then a ten year rate to 1986. From 1986 onwards they use the JP Morgan Australian government bond index based on a maturity of over seven years.

We note that the Commission has considered the issue of consistency between the risk-free rate maturity used to estimate the cost of debt and equity and the maturity that underpins the estimation of the MRP. However, they do not consider that it is necessary to adjust for this.

In our view, this gives rise to a fundamental inconsistency. The impact of this inconsistency depends on the term structure of interest rates, with the yield curve – on average – tending to be upward sloping. An upward sloping yield curve means shorter term bonds will have lower interest rates, and the MRP will be higher. Given the shape and slope of the yield curve varies considerably through time, this needs to be considered over the longer term.

Conclusions

The use of historical information to estimate a forward-looking MRP is logical, but subject to measurement error and distortions. The approach requires an assumption that the conditions underlying the historical returns are expected to be present in the future. Clearly this is a strong assumption and it may not be appropriate when comparing the US equity markets in the twentieth century with those markets going forward from today.

One approach to evaluating whether there has been a shift or trend in the market risk premium over time is to use regression analysis on a long time-series of US data. McKinsey & Company report:[64]

> To test for the presence of a long-term trend, we regress the US market risk premium versus time. Over the last 100 years, no statistically significant trend is observable. Based on regression results, the average excess return has fallen by 3.3 basis points a year, but this result is well below its standard error.

[64] McKinsey & Company, Inc (T. Copeland, T. Koller and J. Murrin) (2005), op.cit, p. 305.

Although the data does not provide statistically significant evidence, it does indicate a small downward trend. Dimson, Marsh and Staunton[65] have observed:

> … there are cogent arguments for going beyond raw historical estimates.

A comprehensive review of the literature in this area is beyond the scope of this report. However, there are four changes that could be particularly important in assessing the US MRP.

There has been an explosion in the breadth of investment alternatives available to investors, both domestic and international. As a result, investors are far better positioned to efficiently diversify their portfolios. This change includes the growth in mutual funds and pension plans. Economies, at least in the industrialised world, have apparently learned to control inflation.[66] This results in interest rate stability, which is a substantial reduction of risk for businesses. A wide range of new financial securities have been introduced that have advanced portfolio risk management tremendously. Finally, and perhaps the most important, transactions and monitoring costs have declined markedly.

Reflecting these changes in an estimate of a long-horizon MRP is necessarily subjective and uncertain. However, there are estimates available from a number of researchers that are highly qualified to make such a judgement.

In an article summarising results of their research on the historical equity premium for 16 countries over 103 years, Dimson, Marsh and Staunton state:[67]

> A plausible, forward-looking risk premium for the world's major markets would probably be on the order of 3% on a geometric mean basis, while the corresponding arithmetic mean risk premium would be around 5%.

It seems unlikely that the authors would include New Zealand in the world's major markets.

In their book (which covers 101 years), they state:[68]

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[65] E. Dimson, P. Marsh and M. Staunton (2003), "Global Evidence on the Equity Risk Premium," Journal of Applied Corporate Finance, v 15, Fall, p 11.

[66] The stability has been shaken somewhat recently. However, stability still seems to be assumed in available long-term forecasts. For purposes here it is sufficient that market participants believe that there will be relative interest rate stability in the future.

[67] E. Dimson, P. Marsh and M. Staunton (2003), "Global Evidence on the Equity Risk Premium," Journal of Applied Corporate Finance, v 15, Fall, pp 27-38. The quotation is on p 37. On the same page they say, "Looking ahead, for capital budgeting purposes, what is required is the arithmetic mean of the distribution of possible equity premiums."

> The result is a forward-looking, geometric mean risk premium for the United States, United Kingdom and world of around 2½ to 4 percent and an arithmetic mean risk premium of US, UK, and world equities that falls within a range from a little below 4 to a little above 5 percent.

Their estimate based on 101 years is a mid-point above 4.5%. Two years later and with two additional years of data, they revised their mid-point estimate upward to 5%.

The UBS Investment Bank report on estimating WACC commented on the MRP in the US:[69]

> We provide pragmatic solutions including: a global market risk premium of about 5%, based on historical data, market expectations, and a review of the literature.

The corporate finance textbook by Brealey and Myers is perhaps the best known and most respected of all. They state the belief that the MRP based on long-horizon bonds is in the range 4.5% to 7%.[70]

McKinsey & Co states: [71]

> Although many in the finance profession disagree about how to measure the market risk premium, we believe 4.5 to 5.5 percent is an appropriate range.

This estimate is for the US and the premium relative to long-term government bonds. Also, we refer to the previous statement made by McKinsey and Company referenced above, where they consider a worldwide MRP and the US MRP as equivalent.

In assessing the available literature and evidence, we estimate that the reasonable range for the forward-looking, long-horizon US MRP is 3% to 7%%. An appropriate point estimate is the mid-point of this range, being 5%.

The last step in estimating a benchmark MRP for New Zealand is to consider factors which are likely to cause a difference between the benchmark MRP and the MRP for New Zealand. We consider differences in taxation, differences in equity markets and

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[68] E. Dimson, P. Marsh and M. Staunton (2002), Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, Princeton, New Jersey, p 194.

[69] UBS Investment Bank (2005), op.cit.

[70] R. Brealey and S. Myers, (2003), Principles of Corporate Finance (7th ed), 2003 (McGraw-Hill/Irwin: Boston), p 160. They state their belief as 6% to 8.5% measured against US Treasury bills. The difference between bills and long-term bonds has historically been about 1.5%.

[71] McKinsey & Company, Inc (T. Copeland, T. Koller and J. Murrin), (2005), op.cit, p 312.

indices, and country risk. Any of these could cause the New Zealand *ex ante* MRP to be different from the US MRP.[72]

7.2.3 Premium for New Zealand over the US MRP

We support the Commission's recognition of the need to consider adjustments to a benchmark MRP for the particular circumstances of the equity markets in New Zealand. This is well recognised in the literature.

Dimson, Marsh and Staunton state:[73]

> There are obviously differences in risk between markets …

Arzac also states:[74]

> The size factor is also present in non-US markets. Thus a small-cap premium has to be added to (the CAPM) when appropriate.

In this text, estimates of the magnitude of the size premium are very supportive of the premium for New Zealand being 2% to 4% above the MRP for the US.

As noted above, McKinsey and Company[75] recommend using a worldwide MRP (which they regard as equivalent to the US MRP), and then adjust that upward for differences in size. We consider differences in the size and composition of the markets, taxes and country risk.

Differences in size and composition of markets

There are many obvious differences between the equity markets in the two countries.

First, to be considered is the composition of the New Zealand market. It has a disproportionate representation of companies in telecommunications and transport. Internationally telecommunications companies tend to have low to moderate levels of systematic risk, but the New Zealand environment, including the role of regulation and the government, is considerably less protective than is generally the case internationally. Transport, particularly air transport, is generally high risk. Further,

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[72] In his WACC report to the Commission on the airfields, Associate Professor Lally says foreign estimates of MRP "are subject to the problem of inter-country differences relevant to market risk premiums, such as market volatilities and personal taxes." This is consistent with our approach.

[73] E. Dimson, P. Marsh and M. Staunton (2002), op.cit., p 193.

[74] E. Arzac (2005), Valuation for Mergers, Buyouts, and Restructuring, John Wiley & Sons, Hoboken, p. 207.

[75] McKinsey & Company, Inc (T. Copeland, T. Koller and J. Murrin), (2005), op.cit.

transport companies in New Zealand will have less benefits of diversification in their transport businesses than would be the case in the US. On balance, we believe the riskiness of New Zealand companies in these industries is somewhat above the average relative to the US.

In US markets there is a higher representation of leading-edge, technology type companies. However, the empirical evidence used to estimate the US MRP is based upon the Standard & Poor's 500 Index. This index comprises 500 of the largest US companies and covers about 75% of the US equity market by capitalization. It consists of a highly diverse set of companies and is not over represented by high-risk companies.

The second consideration is the relative size of the two markets and of the companies in the markets. The total market capitalization of all domestic equities listed on the New Zealand Exchange (NZX) in June 2009 was about NZ$43.7 billion. This is a substantial decline from the value in June 1999 of NZ$51.1 billion. The market value of the New York Stock Exchange is currently about US$20 trillion, over 700 times as large as the NZX.

The Financial Times publishes the Global 500 annually, based upon market capitalization. Thirty-six percent of the companies are based in the US. The entire NZX is about the same market capitalization as Telstra, which ranks 144th. Another comparison is that the entire NZX is smaller than the total of the three smallest companies on the list. The annual net income of the largest company (Exxon Mobil) is about 50% larger than the total market capitalisation of the NZX.

US companies are considerably larger on average. Telecom is the largest company listed on the New Zealand Exchange with a current market capitalization of about NZ$5 billion (about US$3.2 billion). The largest US company is over 100 times larger.

New Zealand is dwarfed by the U.S., both in terms of the total equities markets and the companies that comprise the major market indices. This is important because it is well documented that size is negatively related to risk - both total risk and systematic risk.

Based on Ibbotson data over the period 1926 through 1996, a portfolio of small stocks, defined as the smallest twenty percent of all firms listed on the New York Stock Exchange, showed a return that was 6.52% higher than the return on the S&P500. Note that although the portfolio is labelled small stocks, they are not small stocks as would be thought of with respect to the New Zealand stockmarket.

As a measure of total risk, the standard deviation of the small stocks was nearly double the standard deviation of the S&P500. An estimate of the systematic risk (beta) of the small stocks portfolio can be made by dividing the excess return (over the risk-free rate

of return) of the small stocks by the excess return of the market portfolio (i.e., the S&P500). This calculation gives a portfolio beta for small stocks of 1.75.

Using data for the period 1988 to 2002, the variance (volatility) of the NZ market was 56% higher than that of the S&P500. This is consistent with substantially more risk in New Zealand, although it does not directly translate into systematic risk.

The New Zealand dollar is exceptionally volatile. A recent article by Brian Gaynor documents:[76]

> ...the Kiwi is one of the world's most speculative currencies.

The volatility of the exchange rate is a source of risk to investors for two reasons. New Zealand is an economy with a substantial portion of its business activity impacted by the value of its dollar. The volatility adds risk to the businesses (and/or costs in the form of hedging costs). Further, international investors face exchange rate risk on their investments in New Zealand.

The relatively low level of regulatory surveillance in New Zealand also creates risk for investors. Again, this topic has written about very recently. The Chief Executive and Chairwoman of the Securities Commission, Jane Diplock, is quoted as saying that:[77]

> New Zealand's investor protection was way behind the rest of the world when she arrived (in 2001). Since then, she says, there has been significant progress, but we are not there yet.

It is clear from the article that many people do not agree with Ms Diplock about the progress. Problems touched on in the article include insider trading, conflicts of interest, inadequate oversight of auditors, related party lending, lack of balanced regulatory intervention, and inadequate disclosure. These problems are compounded because many of the enforcement powers of regulations still lie in the hands of shareholders. Further, class action suits are not permitted in New Zealand.

Other issues that are consistent with a difference between the two MRPs include higher liquidity, lower transactions costs, superior surveillance by the stock exchanges, legal protections for shareholders including class action lawsuits, significantly more publicly available financial analysis and far greater availability and range of diversification and risk management securities in the US.

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[76] B. Gaynor (2009), "The Las Vegas of the Currency World", NZ Herald, 4 July.

[77] K. Scherer (2009), "Snapping at the Watchdog", NZ Herald, 10 August.

Based upon the analysis above, it is certainly reasonable to infer that the New Zealand market is higher risk than the US market and hence should have a higher MRP. The challenge is to determine a reasonable way to estimate the magnitude of the higher risk in terms of return.

An intuitive way to apply such analysis to the New Zealand market is to think of it in terms of systematic risk. If the firms in the New Zealand market were listed on a stock exchange with the S&P500 firms, what would be the average beta of the New Zealand firms?

In our opinion, the average beta would likely be in the range of 1.25 to 1.75, with a mid-point estimate of 1.5. To convert this to a rate of return, we use the estimated US MRP of 5% and apply the beta estimate in excess of one to get an addition to the benchmark MRP of 2.5%. The Commission has endorsed the application of "sanity checks" on the estimation of an appropriate cost of capital.[78] In our opinion, a premium of 2.5% on New Zealand equities over the expected return in the U.S. is very reasonable and comfortably passes a sanity check.

Differences in taxation

There are many differences between the system of personal taxation in New Zealand and in the US. The differences that are important here are the tax rates, the New Zealand dividend imputation system, the treatment of capital gains, and the opportunities to shelter tax. Unfortunately, there are a number of complications to this issue.

One problem is that the tax systems have changed over time in both countries. The tax regime that is important is mainly the forward-looking tax system in New Zealand, although historical tax structures may be important to interpreting the US historical MRP data.

A second problem is that the tax systems do not treat all investors the same. The investors we are concerned with are those that are price setters. This almost certainly does not include all investors, but rather includes a relatively small number of highly sophisticated investors. Furthermore, since New Zealand now has open markets, the price setting investors are not likely to be New Zealand taxpayers. It is reasonable to assume for both the US and New Zealand that these investors are skilled at managing their tax affairs to minimise taxation.

[78] Commerce Commission (2009), op.cit., section 2.4.1.

There are obvious differences in the taxation systems between the two countries. At first glance, the differences seem to favour a lower MRP in New Zealand because of the dividend imputation system. But a closer analysis shows that arguments can be made for adjustment in either direction. Unfortunately, this is a complex area. To accurately assess the importance of tax differences to price setting requires that we know the tax circumstances of the price setting investors. We do not know this, but empirical evidence favours a view that there is little difference between the two countries.

Although the magnitude of adjustments to MRP from taxation could be substantial, we do not see a clear basis for predicting the direction. The dividend imputation system would seem to confer an advantage on New Zealand, but if the price setting investors are international, then the advantage would not be reflected in security prices. Further, there are certainly more tax sheltering alternatives in the U.S. tax system. If there is a difference, it may favour New Zealand, but we do not recommend adjusting the US MRP before applying it as a benchmark for estimating the MRP in New Zealand.

Country risk

The incremental risk of a country is often referred to as "country risk". This risk is related to the risk that a government will abruptly alter its policies with respect to investments in the country (including expropriations), shifts in monetary or fiscal policy, regulatory changes, defaults and tax changes.

The literature and empirical evidence support the conclusion that political risk is priced domestically. However, it is likely that the country risk premium for a developed country such as New Zealand is priced in the risk free rate such that there is no additional premium necessary in the MRP. We therefore do not believe it is appropriate to make any further adjustments to the benchmark MRP for country risk.

7.3 Forward-looking estimates of the MRP

In general, there is an inverse relationship between changes in actual returns and the expected (or forward-looking MRP). In other words, when the historical MRP is changing (based on very short-term estimates), the forward-looking MRP will move in the opposite direction. Further, a small movement in the historical MRP can result in quite significant changes in the forward-looking MRP.

This has certainly been observed during the global financial crisis. Following the significant compression in equity returns, which will also compress historical estimates of the MRP (particularly over shorter horizons), significant increases in the expected MRP were observed. However, these estimates are extremely volatile. For this reason,

we do not consider that it is appropriate to rely on these forward-looking estimates to set the MRP, particularly given the asymmetric consequences of error. However, what such differences can do is flag the need for more detailed examination. This is particularly the case where there is a significant difference between forward-looking and historical estimates. At the same time, we need to remain cognisant that short-term forward-looking MRPs are extremely volatile. We must therefore be extremely cautious in drawing any conclusions from these differences, including discarding historical estimates, which may still remain the most appropriate proxy for the longer term forward-looking MRP.

As noted above, in arriving at its recommended estimate of 6.5%, the AER took into consideration the potential impact of the global financial crisis on raising equity capital. In particular, the AER interpreted two possible explanations for the current market conditions, being:

- that the prevailing medium term MRP is above the long-term MRP, but will return to the long term MRP over time; or
- that there has been a structural break in the MRP and the forward looking long term MRP (and consequently also the prevailing) MRP is above the long term MRP that previously prevailed.[79]

This contrasts to previous regulatory debates, which have focussed on whether the value of the MRP has fallen.

It is therefore possible that such a structural break has occurred following the crisis, but this will be difficult to reliably estimate, particularly in the short-term until substantial data has accumulated post-break. In the meantime, however, while caution should be exercised in interpreting and applying forward-looking estimates, we are of the view that the realities facing businesses such as Vector cannot be ignored. These realities are that it is more difficult to raise debt and equity capital. While the market has shown signs of recovery, the likely reality is that uncertainty will continue to prevail for some time.

7.4 Recommended MRP estimate

To estimate a long-horizon MRP for New Zealand, the preceding analysis is summarised as follows:

[79] Australian Energy Regulatory (2009), Electricity Transmission and Distribution Network Service Providers – Review of the Weighted Average Cost of Capital (WACC) Parameters, May, p.238.

- market differences – addition to benchmark of 2.5%;
- taxation – perhaps a small subtraction in favour of New Zealand;
- country risk – no adjustment to MRP.

In our opinion, this analysis indicates that an adjustment to the US MRP should be an increase of about 2.5% or slightly less. We combine this with our estimated long-horizon MRP for the US of 5%. Therefore, in our opinion, an appropriate estimate of a long-horizon MRP for New Zealand is 7.5% under the standard CAPM.

As the Commission favours using the simplified Brennan-Lally version of the CAPM, a further upward adjustment of approximately 1.5% is required (to arrive at a tax-adjusted MRP). This brings our estimate of the post tax MRP to 9.0%.

8 Other issues

8.1 WACC range

We note the Commission's preference to continue to specify a WACC range based on standard deviations. Our preferred approach would be to specify ranges for those parameters that cannot be precisely estimated, such as beta, capital structure and the market risk premium, based on the evidence examined (standard deviations should still be considered for individual estimates, where relevant). In our view, this is a better approach than specifying a point estimate with a standard deviation, as it reinforces that for these key parameters, there are likely to be a range of reasonable outcomes. These ranges can then be used to construct the WACC range, with a point estimate selected from within that range. We note that Professors Myers and Franks also endorsed such an approach.

Finally, as noted upfront we fully endorse the Commission's position to continue to select a point estimate from the upper bound of the range, in recognition of the asymmetric consequences of error. This is also a potential way of dealing with other asymmetric risks such as asset stranding, to the extent that they are not otherwise compensated. For example, this may involve moving to the upper bound of the range (given the 75th percentile recognises the asymmetric consequences of error only, but not issues such as stranding risk).

A Comparator companies

A.1 Gas utilities: mainly transmission/distribution

Australia

APA Group

APA Group (APA) is comprised of the Australian Pipeline Trust and APT Investment Trust. Its principal activities relate to the ownership, management and operation of natural gas transmission and distribution assets across Australia. APA has an interest in approximately 12,000 km of high pressure gas transmission pipelines across mainland Australia, transporting more than half of the natural gas used in Australia annually.

APA owns gas distribution networks in Queensland and New South Wales. It has over 2,800 km of distribution mains. APA also owns the Mondarra gas storage facility in Western Australia, and the Dandenong LNG storage facility in Victoria. APA manages and operates all its gas transmission and distribution assets.

APA has energy investments in the form of minority interests in the following companies:

- Envestra Limited (30.6%) - ASX-listed gas distribution company
- Ethane Pipeline Fund (6.1%) - ASX-listed ethane pipeline company
- Energy Infrastructure Investments (19.9%) - unlisted energy infrastructure company.

It also operates and maintains the assets of these companies.

The gas transmission and distribution activities contributed 85% of APA's EBITDA for the 2007-08 year. The balance of EBITDA is attributable to the three other business segments; electricity transmission, asset management and complementary assets.[80]

[80] APA Group (2008), Annual Report.

Envestra Limited

Envestra Limited operates natural gas distribution networks and transmission pipelines in South Australia, Queensland and the Northern Territory. The Company's networks distribute gas to households and businesses in Adelaide, Brisbane, Alice Springs and various regional centres in South Australia and Queensland.

The company generates its revenue by charging retailers to transport natural gas through its network of 21,000 kilometres of natural gas distribution networks and 1,000 kilometres of transmission pipelines.

Canada

Gaz Metro Limited Partnership

Gaz Metro Limited Partnership is a Quebec energy company and a Canadian natural gas distributor serving customers in Quebec and the north eastern United States (through its wholly owned subsidiary Northern New England Energy Corporation).

Gaz Métro also owns significant investment interests in two natural gas transportation enterprises and an enterprise specializing in underground natural gas storage facilities (Intragaz). Gaz Métro Plus, a subsidiary of Gaz Métro, provides maintenance and repair services for natural gas equipment, urban cooling and heating systems (CDH Solutions & Operations) and leased water heaters, including electric water heaters (HydroSolution). Through various subsidiaries and affiliates, Gaz Métro is also active in water and waste water infrastructure diagnosis and rehabilitation (Aqua Data and Aqua-Rehab) and fibre optics (MTO Telecom).

The net income of Gaz Métro-QDA, which is strongly affected by the rate of return allowed by the Régie on its deemed common equity, represents more than 80% of Gaz Métro's adjusted net income in both 2008 and 2007.

Pacific Northern Gas Ltd

Pacific Northern Gas Ltd owns and operates natural gas transmission and distribution systems. The Company owns and operates natural gas distribution facilities to deliver gas from its pipeline system to homes and businesses in the various communities located throughout the Western system service area. The Western system has three large industrial customers: West Fraser Mills Ltd., Rio Tinto Alcan and B.C. Hydro and Power Authority. In 2007, these three customers accounted for approximately 29 percent of total gas deliveries and 6 percent of the Company's operating revenues. The

Northeast system is served by the Company's wholly owned subsidiary Pacific Northern Gas (N.E.) Ltd.

United States

AGL Resources Inc

AGL is a large distributor of natural gas in the south eastern United States with distribution operations in; Georgia, Tennessee, New Jersey, Maryland, Florida and Virginia. Its retail interests are pursued through SouthStar Energy Services which is a joint venture operating in Georgia under the trade name Georgia Natural Gas. The business supplies natural gas to approximately 526,000 retail and commercial customers in Georgia and to more than 300 interruptible customers throughout the Southeastern United States. SouthStar also provides gas supply to customers in Ohio and Florida.

Its wholesale activities are pursued by Sequent Energy Management which provides services including natural gas asset management, producer and storage services, and full-requirements supply, including peaking needs. AGL also has interests in natural gas storage facilities and telecommunication fiber networks.

Over the period from 2006-2009 on average, AGL derived 84% of the operating segments' EBIT from the regulated natural gas distribution business and the sale of natural gas to retail customers (primarily in Georgia through affiliated company SouthStar).

The remaining operating EBIT for the last three years was derived principally from businesses that are complementary to the natural gas distribution business. They engage in natural gas asset management and the operation of high-deliverability natural gas underground storage as ancillary activities to AGL's utility franchises.

The following chart provides each operating segment's percentage contribution to the total operating EBIT for the last three years.

Atmos Energy Corporation

Atmos Energy is a natural-gas-only distributor in the United States, with distribution services provided in 12 states. The company has recently acquired the distribution and pipeline operations of TXU Gas Company, the largest natural gas distributor in Texas. Atmos Energy is also the largest natural gas distributor in Louisiana and Mississippi and operates one of the largest intrastate natural gas pipelines in Texas. Other activities include wholesale natural gas marketing, provision of pipeline and

storage facilities, and developing distributed-generation electric plants for third parties.

Atmos Energy's unregulated operations are essentially mid-tier natural gas marketing activities. This involves marketing natural gas supplies in 22 states, arranging for gas transportation and management services, managing company-owned and contracted natural gas storage and pipeline assets and building and operating natural gas gathering systems. The company also has regulated distribution operations.

In 2008 net income from regulated operations contributed almost 75% of net income.[81]

Chesapeake Utilities Corporation

Chesapeake Utilities operates in Delaware, Maryland and Florida. The Company consists of four primary business segments: natural gas distribution, transmission and marketing; propane distribution and wholesale marketing; advanced information systems; and other services. The Company distributes natural gas to residential, commercial, and industrial customers in Delaware, Maryland, and Florida. Chesapeake Utilities' propane is distributed to customers in Delaware, Maryland, and Virginia.

Piedmont Natural Gas Company

Piedmont Natural Gas is an energy services company primarily engaged in the distribution of natural gas to one million residential, commercial and industrial utility customers in North Carolina, South Carolina and Tennessee, including 62,000 customers served by municipalities who are wholesale customers. Its subsidiaries include joint venture, energy-related businesses, including unregulated retail natural gas marketing, interstate natural gas storage and intrastate natural gas transportation.

Southwest Gas Corporation

Southwest Gas Corporation purchases, transports, and distributes natural gas to residential, commercial, and industrial customers in portions of Arizona, Nevada, and California. The company also provides construction services to utility companies, including trenching and installation, replacement, and maintenance services for energy distribution systems.

[81] Atmos Energy (2008), Annual Report, p.4.

WGL Holdings Inc

WGL Holdings sells and delivers natural gas and provides a variety of energy-related products and services to customers primarily in the District of Columbia, and the surrounding metropolitan areas in Maryland and Virginia.The core business of WGL Holdings is its natural gas delivery business.[82] Its unregulated subsidiaries provide energy-related services to residential and commercial customers, including government organizations.

Northwest Natural Gas Company

Northwest Natural Gas Company is a regulated natural gas local distribution and storage company headquartered in Portland, Oregon. NW Natural purchases natural gas for its core market from a variety of suppliers in the western United States and Canada. The company operates gas storage facilities in its service territory, contracts for additional gas storage outside its service territory, and provides gas storage services to other energy companies in the Northwest. It has no other significant business activities outside natural gas.

The Laclede Group

The Laclede Group is the parent organization of the regulated core utility component — Laclede Gas Company — and of an unregulated component being developed to achieve sustainable growth. The Laclede Group's largest unregulated activity is Laclede Energy Resources, a subsidiary engaged in marketing natural gas and related activities.

Laclede Gas Company is the largest natural gas distribution utility in Missouri, serving approximately 631,000 residential, commercial and industrial customers in the City of St. Louis and ten other counties in eastern Missouri.

In 2008 the regulated gas distribution business accounted for around 50% of total revenues.[83] The unregulated gas marketing business accounted for most of the remaining revenue.

[82] WGL Holdings Inc (2008), Annual Report, p.22.

[83] Laclede Group (2008), Annual Report, p.1.

Corning Natural Gas (USA)

Corning Natural Gas Corporation is an investor-owned local distribution company that provides natural gas, transportation, storage and other unbundled energy services. The service territory, encompassing an area of about 400 square miles, is located in the Finger Lakes area of the Southern Tier of New York State. Corning Natural Gas is franchised to serve fifteen townships with 385 miles of pipeline through 14,000 meters. The Company provides wholesale gas delivery services to NYSEG in Elmira, N. Y. and to the Village of Bath, N. Y.

RGC Resources Inc (USA)

RGC Resources, Inc. provides energy and related products and services to customers in Virginia and West Virginia through its operating subsidiaries including Roanoke Gas Company, Bluefield Gas Company, Diversified Energy Company and RGC Ventures of Virginia, Inc. A subsidiary, Application Resources, is an application solutions provider based in Southwestern Virginia.

In 2007, the natural gas business accounted for around 99% of revenues.[84]

A.1 Electricity utilities: mainly transmission/distribution (US)

Exelon Corporation (US)

Exelon Corporation is a utility services holding company. The Company, through its subsidiaries distributes electricity to customers in Illinois and Pennsylvania. Exelon also distributes gas to customers in the Philadelphia area as well as operates nuclear power plants in states that include Pennsylvania and New Jersey. Its other activities include; fossil and hydroelectric power generation, wholesale marketing and business services.

[84] RGC Resources Inc (2008), Annual Report, p.1.

Pepco Holdings Inc (US)

Pepco Holdings Inc (PHI) is a large diversified energy delivery company based in the Mid-Atlantic region, serving about 1.9 million customers in Delaware, the District of Columbia, Maryland and New Jersey. PHI subsidiaries Pepco, Delmarva Power (DPL) and Atlantic City Electric (ACE) provide regulated electricity services; DPL also provides natural gas service. Pepco, DPL and ACE are regulated utilities in the jurisdictions that comprise its service territory.

PHI provides competitive wholesale generation services through Conectiv Energy and retail energy products and services through Pepco Energy Services.

The largest component of PHI's business is Power Delivery, which consists of the transmission, distribution and default supply of electricity and the delivery and supply of natural gas. In 2008, 2007 and 2006, respectively, PHI's Power Delivery operations produced 51%, 56%, and 61% of PHI's consolidated operating revenues (including revenue from intercompany transactions) and 72%, 66%, and 67% of PHI's consolidated operating income (including income from intercompany transactions).

The Competitive Energy businesses provide competitive generation, marketing and supply of electricity and natural gas, and related energy management services primarily in the mid-Atlantic region. These operations are conducted through subsidiaries of Conectiv Energy and Pepco Energy Services. For the years ended December 31, 2008, 2007 and 2006, PHI's Competitive Energy operations produced 53%, 48%, and 43%, respectively, of PHI's consolidated operating revenues and 36%, 26%, and 20%, respectively, of PHI's consolidated operating income.

A.2 Integrated businesses

A short description of each of the integrated businesses is provided in the table below.

Company	Description
GAS UTILITIES	
National Fuel Gas Company (US)	National Fuel Gas Company is an integrated natural gas company with operations in all segments of the natural gas industry, including utility, pipeline and storage, exploration and production, and marketing operations. The Company operates across the United States.
EQT Corporation (US)	EQT Corporation is an integrated energy company with emphasis on Appalachian area natural-gas supply, transmission and distribution. The Company, through its subsidiaries, offer natural gas products to wholesale and retail customers.
Energen Corporation (US)	Energen Corporation is a diversified energy holding company. The Company acquires, develops, explores, and produces oil, natural gas and natural gas liquids in the continental United States. The Company also purchases, distributes and sells natural gas, principally in central and north Alabama.
UGI Corporation (US)	UGI Corporation distributes and markets energy products and services. The Company is a domestic and international distributor of propane. UGI also distributes and markets natural gas and electricity, and sells related products and services in the Middle Atlantic region of the United States.
Ferrellgas Partners (US)	Ferrellgas Partners, L.P. sells, distributes, markets, and trades propane and other natural gas liquids. The Partnership serves residential, industrial/commercial, portable tank exchange, agricultural, wholesale and other customers throughout the United States, the District of Columbia, and Puerto Rico.
Delta Natural Gas Company (US)	Delta Natural Gas Company, Inc. distributes, stores, transports, gathers, and produces natural gas. The Company, through its subsidiaries, buys and sells gas, as well as operates underground storage and production properties.
Nicor Inc (US)	Nicor Inc. is holding company. The Company, through its subsidiaries, provides gas distribution services in Illinois as well as containerized freight transportation services the Bahamas and the Caribbean region. Nicor als provides energy-related products and services to retail markets and markets natural gas on a wholesale basis.
South Jersey Industries Inc (US)	South Jersey Industries, Inc. is an energy services holding company. The Company provides regulated, natural gas service to residential, commercial, and industrial customers in southern New Jersey. South Jersey also markets total energy management services, including natural gas, electricity, demand-side management, and consulting services throughout the eastern United States.
ELECTRIC UTILITIES	
Other integrated electric	
FPL Group (US)	FPL Group, Inc. is a holding company. The Company, through its subsidiaries, generates, transmits, distributes, and sells electric energy utilizing natural gas, wind and nuclear resources.
Duke Energy Corporation (US)	Duke Energy Corporation is an energy company located primarily in the Americas that owns an integrated network of energy assets. The Company manages a portfolio of natural gas and electric supply, delivery, and trading businesses in the United States and Latin America.
Entergy Corporation (US)	Entergy Corporation is an integrated energy company that is primarily focused on electric power production and retail electric distribution

Company	Description
	operations. The Company delivers electricity to utility customers in Arkansas, Louisiana, Mississippi, and Texas. Entergy also owns and operates nuclear plants in the northern United States
American Electric Power Company (US)	American Electric Power Company, Inc.(AEP)is a public utility holding company. The Company provides electric service, consisting of generation, transmission and distribution, on an integrated basis to their retail customers. AEP serves portions of the states of Arkansas, Indiana, Kentucky, Louisiana, Michigan, Ohio, Oklahoma, Tennessee, Texas, Virginia and West Virginia.
FirstEnergy Corp (US)	FirstEnergy Corp. is a public utility holding company. The Company's subsidiaries and affiliates are involved in the generation, transmission and distribution of electricity, exploration and production of oil and natural gas, transmission and marketing of natural gas, and energy management and other energy-related services.
Allegheny Energy (US)	Allegheny Energy, Inc. is an electric utility holding company. The Company, through various subsidiaries, serves customers in parts of Pennsylvania, West Virginia, Maryland and Virginia.
Northeast Utilities (US)	Northeast Utilities is a public utility holding company. The Company, through its subsidiaries, provides retail electric service to customers in Connecticut, New Hampshire, and western Massachusetts. Northeast also distributes natural gas throughout Connecticut.
DPL Inc (US)	DPL Inc. is a holding company whose principal subsidiary is The Dayton Power and Light Company. Dayton Power & Light sells electricity to residential, commercial, and government customers in west central Ohio.
NV Energy Inc (US)	NV Energy, Inc., through its subsidiaries, generates, transmits, and distributes electric energy throughout Nevada and the Lake Tahoe area of California. Additionally, the company provides natural gas services in the Reno Sparks area of Nevada.
Westar Energy (US)	Westar Energy, Inc. is an electric utility company servicing customers in Kansas. The company provides electric generation, transmission and distribution services.
Great Plains Energy Incorporated (US)	Great Plains Energy Incorporated provides electricity in the Midwest United States. The Company develops competitive generation for the wholesale market. Great Plains is also an electric delivery company with regulated generation. In addition, the Company is an investment company focusing on energy-related ventures nationwide that are unregulated with high growth potential.
Cleco Corporation (US)	Cleco Corporation generates, transmits, distributes, and sells electric energy to customers in Louisiana. The Company, through a subsidiary, also markets energy and energy management services. In addition, the Company is involved in energy asset development opportunities in the Southeastern region of the United States.
Idacorp Inc (US)	IDACORP, Inc is the holding company for Idaho Power Company, an electric utility and IDACORP Energy, an energy marketing company. Idaho Power generates, purchases, transmits, distributes, and sells electric energy in southern Idaho, eastern Oregon, and northern Nevada. IDACORP Energy maintains electricity and natural gas marketing operations.
Allete Inc (US)	ALLETE, Inc. provides energy services in the upper Midwest United States. The Company generates, transmits, distributes, markets, and trades electrical power for retail and wholesale customers.
Unisource Energy Corporation (US)	Unisource Energy Corporation is the holding company of Tucson Electric Power Company. The Company generates, purchases, transmits, distributes, and sells electric energy to retail and wholesale customers. Unisource also owns all of the outstanding common stock of Millennium Energy Holdings, Inc.
UIL Holdings Corporation (US)	UIL Holdings Corporation, through The United Illuminating Company, provides electricity and energy-related services to customers and municipalities in Connecticut. The Company's other subsidiary, United

Company	Description
	Resources Inc., is the umbrella for UIL's non-regulated business units, including Precision Power, American Payment Systems, United Capital, and United Bridgeport Energy.
El Paso Electric Company (US)	El Paso Electric Company generates, distributes, and transmits electricity in west Texas and southern New Mexico. The Company also serves wholesale customers in Texas, New Mexico, California, and Mexico. El Paso Electric owns or has partial ownership interests in electrical generating facilities.
The Empire District Electric Company (US)	The Empire District Electric Company generates, purchases, transmits, distributes, and sells electricity. The Company supplies electricity to parts of Missouri, Kansas, Oklahoma, and Arkansas. Empire also provides water service to several towns in Missouri.
Central Vermont Public Service Corporation (US)	Central Vermont Public Service Corporation purchases, produces, transmits, distributes, and sells electricity. The Company serves customers in Vermont. Central Vermont's subsidiary distributes and sells electricity in parts of New Hampshire bordering the Connecticut River.
TrustPower Limited (New Zealand)	TrustPower Limited is a regional New Zealand power company which operates electricity generation networks and also supplies and distributes electricity and other related services to customers. TrustPower also has operations in retailing electricity throughout New Zealand.