A Framework for Quantifying Estimation Error in Regulatory WACC

A REPORT FOR PRIME INFRASTRUCTURE IN RELATION TO QCA'S DRAFT DETERMINATION IN RELATION TO DALRYMPLE BAY COAL TERMINAL

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EXECUTIVE SUMMARY

This paper has been prepared by SFG Consulting for Prime Infrastructure to submit as part of the consultation process of the Queensland Competition Authority (QCA) in relation to the Dalrymple Bay Coal Terminal (DBCT) Draft Determination.

We have not sought to change the accepted Australian regulatory approach to the setting of an appropriate allowable rate of return (WACC), including utilising the Capital Asset Pricing Model, and the building block approach. Rather, our approach is simply to recognise the uncertainty involved in estimating the appropriate WACC and to quantify and adjust for the likely error in this estimate. That is to say, the WACC established by the Authority is an estimate of the entity's cost of funds. It is computed as the aggregation of a number of parameter estimates where some of these parameters are estimated with considerable estimation error. The entity's true cost of funds might therefore be more or less than the Authority's estimate.

The paper establishes a framework for quantifying the uncertainty in the estimated weighted-average cost of capital (WACC) of a regulated entity. We demonstrate how to identify and quantify the uncertainty in estimates of various WACC parameters and show how this aggregates into uncertainty about the estimated WACC. We also develop a framework for quantifying the uncertainty in the true cost of funds of the regulated entity. In particular, we use standard Monte Carlo simulation techniques to construct a full probability distribution around the WACC estimate. This can be interpreted as a probability distribution of the true cost of funds of an efficient benchmark entity. From this, it is possible to compute the probability that a given regulatory WACC will be insufficient to meet the cost of funds of an efficient benchmark entity. This assists regulators to assess the possible financial impacts of their determinations.

It is important to note that what is proposed here is entirely consistent with the Authority's DBCT Draft Determination. The framework for estimating WACC, the building block approach and even the economically reasonable ranges for individual parameter estimates are all consistent with the DBCT Draft Determination. All that is proposed here is a mechanism for:

1. Recognising and quantifying the statistical and economic uncertainty that surrounds estimates of several key WACC parameters.

2. Recognising and incorporating the inter-relationships between imprecisely estimated parameters. For example, the equity beta depends on estimates of the asset beta and debt beta, which indirectly depends on estimates of the market risk premium, debt margin and gamma.

3. Constructing a standard probability distribution for the WACC – a probability distribution of the true cost of funds of an efficient benchmark entity.

The approach that is adopted in the Draft Determination recognises the uncertainty in some parameter estimates by specifying a range. The Authority resolves this uncertainty by selecting a point estimate from within the range and then uses these point estimates to compute the regulatory WACC. Under this approach of selecting point estimates for each parameter before aggregating into a single estimate of WACC, the complex inter-relationships between parameters and estimation uncertainty is lost. It is possible to select a point estimate for every parameter from within an economically reasonable range, but to end up with a WACC estimate that gives the regulated business little chance of earning its true cost of funds. What we propose here is nothing more than a minor change to the order of these operations. We propose to specify an economically reasonable range for each parameter, from which we construct a standard probability distribution for the

WACC. This allows the Authority to select an appropriate WACC from within the probabilistic range. The only real difference is that regulatory judgment is applied at the aggregated WACC level in a formal probabilistic framework, rather than arbitrarily applied to each individual parameter.

Our approach acknowledges that the building block parameters, and in particular the market risk premium, the asset beta and the debt margin, cannot be estimated with any great precision. Accordingly, in our analysis:-

- The risk free rate, gearing, corporate tax rate, and value of franking credits is held fixed at the values prescribed in the Draft Decision;
- Values for the market risk premium, asset beta, and debt margin are drawn from their respective probability distributions (reflecting the uncertainty with which they are estimated). Importantly, however, the economically reasonable ranges for individual parameters are conservative and are drawn mainly from the estimates used by the Authority in the Draft Decision;
- An upper bound for the debt beta is calculated by reverse engineering the CAPM (with its lower bound set at zero);
- Values for all of the WACC parameters are now available and the nominal post tax vanilla WACC can be computed;
- This process is repeated ten thousand (10,000) times yielding a histogram of WACC estimates, which should be interpreted as a probability distribution of the firm's true cost of funds (vanilla post-tax WACC).

This approach explicitly measures the probability that the regulatory WACC will result in DBCT Management earning a realised rate of return that is insufficient to cover its true cost of capital. We propose to set the WACC such that there is a 25% probability that the regulatory WACC is insufficient to cover DBCT Management's true cost of capital (i.e., that there is a 75% chance that the allowed return will be sufficient to meet DBCT Management's efficient true cost of funds). Our proposal is designed to balance the regulator's objectives of:

- Ensuring the TIC paid by the Users is not higher than it needs to be; and
- Ensuring returns are sufficient to ensure the viability of DBCT Management and provide sufficient incentives for future expansion investment.

The non-recovery probability would be set at 50% if these objectives were equally weighted. However, they are not. Setting the non-recovery probability at 25% reflects the fact that it is more important to ensure the viability of the business than to ensure that customers pay the minimum possible cost. In this regard, we note that:

- Setting a 75% probability of being able to earn a return sufficient to cover the true cost of funds is consistent with the notion that ensuring the ongoing viability of the business and creating the right incentives for future investment is more important than keeping prices to a minimum;
- This view is supported by the Productivity Commission, on the basis of asymmetry in the costs of under- and over-compensation of facility owners (i.e. under-compensation has far greater long term costs than over-compensation) and with the informational uncertainties facing regulators;
- This view is also supported by the Commonwealth Government, which has resolved to amend the Trade Practices Act in this regard; and
- This view is supported by commercial practice. Many studies have shown that firms make investment decisions based on hurdle rates that exceed the estimated WACC.

This framework should assist the Authority to meet its statutory requirements[1] of having regard to:

(i) *The access provider's legitimate business interests and investment in the facility;*
(ii) *The public interest, including the benefit to the public in having competitive markets;*
(iii) *The economically efficient operation of the facility.*

This is in the sense that if the chance that the access provider will cover their true cost of funds is, for example, only 50%, there is little incentive to invest. Few commercial projects would be approved if there were a significant chance of returning less than the cost of funds.

This approach is also consistent with a number of recent legal and administrative decisions in the Australian regulatory system as well as recent industry reviews conducted by the Productivity Commission. In this regard, we present arguments about the consequences of setting the allowed return too low and evidence about what is required to provide the right incentives for future investment.

In applying this framework to DBCT, we conclude that **it is appropriate for the Authority to set the post-tax nominal vanilla WACC at no less than 8.9%.** At this WACC, there is a 75% chance that the allowed return is sufficient to meet the true cost of funds of an efficient benchmark entity. This estimate is very conservative, and based on the data relied on by the Authority in reaching its Draft Decision regarding WACC.

Further, if the Authority's estimate of MRP does not include the value of franking credits and it is adjusted to include it, a regulatory WACC of 9.9% provides a 75% chance of being able to recover the true cost of funds (see Section 5 for further discussion).

[1] Queensland Competition Authority Act 1997, Part 5, s120.

1. OVERVIEW

The Queensland Competition Authority (QCA) is responsible for the economic regulation of certain infrastructure assets in Queensland. Most recently, the Authority has reviewed the access arrangements at the Dalrymple Bay Coal Terminal (DBCT), issuing a Draft Determination. This paper has been prepared for Prime Infrastructure to submit in response to the Authority's Draft Determination. It outlines a framework for quantifying the uncertainty surrounding the estimated return on capital – an issue that is particularly important in light of a number of recent legal and administrative decisions. The paper proposes an approach that is entirely consistent with the building block approach, framework for estimating WACC, and even the economically reasonable ranges for individual parameter estimates used by the Authority in the DBCT Draft Determination.

In the Australian regulatory environment, the regulated firm's revenue requirement is constructed using a building block approach. One important component of the revenue requirement is the return on capital. This often represents 30-40% of the regulated firm's revenue requirement, and is even higher in this case. The return on capital is computed as the product of the regulatory asset base (RAB) and the weighted-average cost of capital (WACC). WACC is computed in accordance with one of the possible cost of capital formulas that have been proposed in the corporate finance literature and have been adopted in practice. There are various specifications of WACC depending on whether it is to be applied to real or nominal cash flows and whether various tax effects (notably, the deductibility of interest payments and the potential value of franking credits) are incorporated in the WACC or the cash flows. Whatever the specification that is chosen by the regulator, the WACC is estimated as a mathematical combination of several parameters. Each of these parameters is (or should be) estimated with reference to market data.

Most (perhaps all) of these WACC input parameters are unobservable and have to be estimated or inferred from observable data. For example, CAPM betas are usually estimated by regressing the stock returns of comparable listed firms on stock market returns. The estimate of the slope coefficient then forms the basis for an estimate of beta. Of course, any differences between the comparable firm and the firm being regulated (e.g., a different capital structure) must also be accounted for. The point here is that betas are not *observed* nor *computed*, they are *estimated*. Even with the best of tools, the regulator's estimate of beta may be above or below the true value. No amount of analysis can ever identify the true value—the best that can be done is to identify a probabilistic range within which the true value is likely to lie.

Another example is the market risk premium (MRP)—the expected return on the market portfolio of risky assets in excess of the return on the risk-free asset. The key piece of data used to estimate the MRP is usually the mean of observed premia (stock market index returns less government bond yields) over some historical period. Perhaps the most basic statistical concept of all is that the mean of a sample is an *estimate* of the true value. In a large sample, the true value would be drawn from a normal distribution centered around the sample estimate. Again, we can never hope to identify the true MRP—the best that can be done is to identify a probabilistic range within which the true value is likely to lie. The same issue applies to many other WACC input parameters. These parameters cannot be observed or computed, but can only be estimated—often quite indirectly. For example, the value of franking credits is often inferred from observing how stock prices change on ex-dividend days.

The fact that a number of input parameters cannot be estimated precisely but can only be narrowed to a reasonable range, inevitably means that it is impossible to express the WACC estimate (which is a mathematical aggregation of the input parameters) as a single point estimate. The estimated WACC must, itself, be expressed as a reasonable range. The width of this range depends on the aggregated uncertainty of the imprecisely estimated input parameters.

The purpose of this paper is to:

1. Identify the sources of uncertainty in estimating WACC parameters.
2. Quantify the uncertainty around the estimation of each WACC parameter.
3. Demonstrate how uncertainty around each parameter aggregates into uncertainty about the true cost of funds of an efficient benchmark firm and quantify the uncertainty around this true WACC.
4. Develop a framework for determining an appropriate regulatory WACC in light of estimation uncertainty.

2. WACC ESTIMATION ERROR

2.1. ESTIMATION ERROR

It is well recognized in corporate finance practice and in the relevant literature that a firm's cost of capital can only be estimated imprecisely. The leading paper on the quantification of this uncertainty is Fama and French (1997), who focus on estimation error in estimating the cost of equity. In particular they note that there can be substantial measurement error associated with estimating a firm's cost of equity. This uncertainty stems from two sources: the market risk premium $\left(R_M - R_f\right)$ and the risk loading (β) are both estimated with error. This estimation error means that we cannot be sure of the "true" parameter values. We are able to measure, however, confidence intervals from the estimated parameters' standard errors. To illustrate the issue, and quantify the uncertainty to some extent, Fama and French construct confidence intervals for cost of equity estimates at the industry level.

A further complication arises when we are interested in knowing an individual firm's cost of equity. This arises because industry standard errors for risk loadings are likely to understate the standard errors for individual firms due to the averaging process that a portfolio of firms affords. In this regard Fama and French (1997) state, "…the risk loadings for individual firms or projects are less precise than those of industries, the standard error of costs of equity for firms or projects are even larger."

As a minimum we can examine the effects on industry-average costs of equity resulting from the uncertainty surrounding the estimation of inputs into the cost of equity calculation.

For a variety of scenarios, Fama and French (1997) consider the individual and net contribution of risk factor (MRP) and risk loading (β) uncertainty upon the implied uncertainty in the cost of equity. The results are not encouraging in the quest to precisely quantify a firm's cost of equity.

The authors state that, "large standard errors (in industry costs of equity) are driven primarily by the uncertainty about the true factor risk premiums, with some help from imprecise estimates of period-by-period risk loadings."

Taking the CAPM as our benchmark, the average standard error in the cost of equity resulting from uncertainty in the estimation of the market risk premium alone is at least three percent. The marginal contribution from uncertainty in estimating beta makes the total standard error even greater.

Even starting with the highly unlikely assumption that the risk premium is estimated without error, there is sufficient variation in risk loadings (betas) alone to warrant concern. Fama and French (1997) report results that support a 95 percent confidence interval around the mean cost of equity of more than three percent.

What can we conclude from these results? It is safe to say that the CAPM does not provide any degree of comfort in being able to state precisely and without reservation what the cost of equity actually is. Confidence intervals around the estimated cost of equity are extremely wide. Furthermore, firm specific estimates would have even greater uncertainty than the industry results that are reported. The merits of the asset pricing approach to cost of equity estimation are perhaps best summed up by Fama and French (1997) themselves: "…uncertainty of this magnitude about risk premiums, coupled with the uncertainty about risk loadings, implies woefully imprecise estimates of the cost of equity."

In the Australian regulatory setting, the issue is even broader than Fama and French (1997) suggest. The Australian regulatory setting requires the estimation of a weighted-average cost of capital (WACC). This WACC is computed using a building block approach—the estimated WACC is the compilation of a number of parameters, each of which is measured with some uncertainty. The degree of uncertainty is lower for some parameters (e.g., the risk-free rate) and higher for others (e.g., the market risk premium).

Australian regulators have acknowledged this uncertainty in different ways. IPART, for example, uses a range, rather than a point estimate, for some parameters. IPART then produces a WACC range by aggregating parameters at one end of the range and then at the other. This process acknowledges uncertainty and estimation errors, but falls short of providing a probabilistic framework. That is, it is probably more likely that the firm's true cost of funds falls near the middle rather than near the end points of the IPART WACC range, but we don't know how much more likely—we don't know the relative probabilities of where, within the range, the firm's true cost of funds may lie.

Other Australian regulators acknowledge that certain input parameters cannot be precisely estimated and propose a range for some parameters. The more common process is for the regulator to then use some discretion or judgment to choose an appropriate point estimate from within the range. This too prevents the estimation uncertainty in the computed WACC from ever being explicitly recognized or properly quantified.

We conclude that:

1. **There is significant uncertainty and estimation error involved when estimating a firm's cost of capital. Fama and French (1997) clearly and systematically document this uncertainty. The source of this uncertainty is that building block parameters cannot be estimated with great precision (in particular the market risk premium, the asset beta and the debt margin).**

2. **A firm's WACC is *estimated*, not *computed*. The true cost of funds of an efficient benchmark firm may be higher or lower than this estimate.**

3. **It is particularly important in a regulatory setting to not just recognize the existence of uncertainty and estimation error, but also to quantify it as precisely as is reasonably possible. That is, it is important to quantify the probability that the true cost of funds is higher or lower than the estimated WACC, and by how much.**

2.2. QUANTIFICATION OF UNCERTAINTY

This section describes a process for modeling the uncertainty involved in the WACC estimation process. It also shows how to quantify the extent to which the estimated WACC may differ from the firm's true cost of funds[2].

In particular, we recognize that certain WACC input parameters are imprecisely estimated. For these parameters, we use a range or distribution rather than a point estimate. These parameter estimates and ranges are summarized in Table 1 and discussed below.

[2] Throughout this paper we use the term "firm's true cost of funds" to mean the true cost of funds of an efficient benchmark firm. This term should not be read as meaning the actual realized cost of funds of a particular firm.

Table 1: WACC parameter estimates

Parameter	Symbol	Source	Estimate	Distribution
Risk-free rate of interest	r_f	Yield on 10-year Government bond (20-day average).	5.84%	—
Capital structure	D/V	Comparables and regulatory decisions.	60%	—
Debt margin	—	BBB-BBB+ CBA Spectrum corporate bond yields plus issuance costs.	1.15 – 1.58%	Uniform
Asset beta	β_a	Comparables and regulatory decisions.	0.3-0.5	Uniform
Market risk premium	MRP	Historical stock returns and 10-year govt. bond yields and regulatory decisions.	Mean=6%, Std Dev=1.8%[3]	Normal
Tax rate	τ	Statutory rate.	0.30	—
Value of Franking Credits	γ	QCA, DBCT Draft Determination.	0.50	—
Debt Beta	β_d	Market practice, reverse-engineering CAPM.	$0 - \frac{\text{Debt Margin}}{\text{MRP}}$	Uniform

RISK-FREE RATE

The risk free rate is estimated as the average yield, over the 20-day period prior to the Determination date, on nominal Government Bonds with a 10-year term to maturity. The average yield over the 20 days prior to the relevant reset date of 1 July 2004 was 5.84%. This estimate was used by the Authority in the Draft Determination and is adopted here.

CAPITAL STRUCTURE

There is a wide range of capital structures among comparable firms in Australian, U.S. and U.K. markets. On average, these comparables have around 50% debt financing. This issue has been addressed in many Australian regulatory determinations relating to a range of infrastructure businesses. Australian regulators have developed a strong precedent for the use of 60% debt as the benchmark financing assumption. As this assumption is reasonably consistent with market practice, we adopt a 60% gearing assumption for our analysis.

DEBT MARGIN

The debt margin is a premium that is added to the risk-free rate to estimate the appropriate cost of debt financing. The debt margin reflects the creditworthiness of the entity, supply and demand conditions in the relevant debt markets at the time the debt is assumed to be raised, and any debt raising or establishment costs. Creditworthiness is usually quantified in terms of a credit rating that

[3] Normal distribution with mean 6% and standard deviation 1.8%, consistent with historical variation in observed market risk premia.

reflects the business risk of the entity and the benchmark level of gearing. Australian regulatory precedent is to use a credit rating of BBB to BBB+ for a regulated infrastructure business with 60% gearing. This is reasonably consistent with market practice and with the submissions of both Prime Infrastructure and the users of DBCT, who both suggested that a BBB-rating would be appropriate. The Authority, via its consultants, has based its estimate of the debt margin on the spread between 10-year BBB+ bonds with comparable government bonds. The Authority notes that there is only a single market observation available, at a spread of 122 basis points.

The Authority correctly notes that there is substantial uncertainty around the estimate of an appropriate debt margin, The Authority notes that, "direct market evidence for 10-year BBB+ rated debt in Australian markets is very thin, and therefore, somewhat uncertain".[4] The Authority also notes that there is a high degree of uncertainty surrounding estimates from CBA Spectrum and Bloomberg: "The uncertainty surrounding the market data also affects their estimates."[5]

The Authority, via its consultants, therefore measures a range, rather than point estimate, for the debt margin. This range is constructed as the minimum and maximum of the CBA Spectrum BBB+ debt premium over the 20 days preceding 1 July 2004. It should be noted that the proposed range of 106-119 basis points does not encompass the only available observation of a BBB+ bond, which trades at a spread of 122 basis points. A better way to encompass this uncertainty is to examine the range of actual observations around the CBA Spectrum estimate for deeper markets. This reveals that actual bonds frequently trade 10-20 bps above and below the estimated yields. Taking the 20-day average spread of 112.5 bps, and adding a range of ± 10 bps to accommodate estimation uncertainty produces a range of 102.5 - 122.5 bps, which at least encompasses the only available observation.

Of course, this all assumes that a BBB+ rating is known with certainty. But this too is only an estimate, based on an analysis of the financial ratios which form part of the considerations of rating agencies. Even the best empirical models cannot accurately map financial ratios to credit ratings with great accuracy. Financial ratios cannot be used to accurately distinguish between BBB and BBB+ ratings.

Whereas this information is relevant, and the Authority's consultants have been thorough in this regard, it should be recognized that there is some uncertainty in estimating an appropriate credit rating. At a minimum, the possibility that a BBB rating might be appropriate should be considered. This is particularly so, given that Prime Infrastructure and user group both submitted a credit rating estimate of BBB. Note that we do not suggest that the Authority's estimate of BBB+ should be replaced, only that there is some uncertainty about this estimate and that a BBB rating is an economically plausible possibility. Over the 20 days prior to 1 July 2004, CBA Spectrum reports that 10-year BBB-rated bonds traded at a yield 10 basis points higher than comparable BBB+ bonds.

Finally, there is uncertainty about the appropriate size of debt issuance costs. The Authority uses 12.5 bps, based on a recommendation from its consultants, but recognizes that this allowance was recently doubled on appeal by the Australian Competition Tribunal (ACT). Again, this is an estimate, not a precise observation, so uncertainty should be reflected in the analysis. In particular, the precedent set by the ACT should at least be considered a plausible possibility. For this reason, we adopt a range of 12.5 bps (used by the Authority) to 25 bps (established by the ACT).

[4] Draft Determination p. 189.

[5] Draft Determination p. 189.

Aggregating the uncertainty over the appropriate credit rating, the spread for a given rating, and the uncertain debt issuance costs, produces a range for the debt premium of 115 – 158 basis points.

ASSET BETA

It is well-known that betas cannot be *computed* or *measured* but can only be *estimated* from (noisy) market data. The Authority, via its consultants, recognizes this by establishing a range for its estimate of an asset beta. Based on data from three comparable firms, a range of 0.3 - 0.4 is proposed. The Draft Determination and consultants' report are both silent on the process by which this range was set. It appears to be based on judgment and not on any statistical quantification of estimation error.

We are aware that the consultants' report has been heavily criticized on several grounds. Some of the relevant criticisms are:

- The set of comparable firms is extremely small (3).
- The set of comparable firms contains only one port--a small port in New Zealand.
- The number of observations available for estimating betas of comparable firms is smaller than is usually used for this purpose.
- The non-synchronous trading problems that arise when weekly data are used are ignored[6].
- The substantial uncertainty is not quantified or addressed in the report.

Many criticisms have also been made of the fundamental analysis in the consultants' report, but these are less relevant for the current purpose.

The approach that is adopted in this paper requires only that an economically reasonable range be specified for each parameter. We do not require a single point estimate to be specified for every parameter. In specifying an appropriate range for the asset beta, the key considerations are:

- The statistical uncertainty of individual beta estimates.
- The statistical uncertainty of the process of averaging the beta estimates of a sample of comparable firms.
- The statistical uncertainty that arises from using uncertain estimates of other parameters in the unlevering procedure (e.g., the debt beta is a rough estimate at best).
- Regulatory precedent.
- Common sense.

The first point to note is that the estimates of equity betas for individual firms are woefully imprecise. Indeed they are so imprecise as to be effectively useless. For example, the Centre for Research in Finance (CRIF) at the AGSM reports that the standard errors of its equity beta estimates for MIG and Macquarie Office Trust are 0.42 and 0.19 respectively.

The standard statistical method of forming a range to reflect estimation uncertainty is via a 95% confidence interval. This range is formed by adding and subtracting two standard errors to the point estimate. With such wide standard errors, the resulting range is very large indeed, and covers almost every economically sensible value (and many that are not economically sensible).

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[6] See Scholes, M., & Williams, J. (1977). Estimating Betas from Nonsynchronous Data. Journal of Financial Economics, 5, 309-327.

In practice, this estimation uncertainty is usually reduced by adjusting raw beta estimates (e.g., the Bloomberg procedure) or by computing industry or portfolio betas. If a large portfolio is used, the idiosyncratic estimation errors that affect individual firms tend to cancel as they are not systematic. Thus, portfolio betas tend to be more economically reasonable and are estimated more precisely (have lower standard errors).

In the case at hand, the Authority's consultants form a portfolio of only three comparable firms. Therefore, the statistical imprecision of individual beta estimates remains.

A critique by NERA[7] (p. 28) shows that even if all betas in the set of comparables are precisely estimated, there is still uncertainty in that there is a range of estimates among the comparables. Even if we ignore the great uncertainty surrounding the estimation of each individual beta, there is still uncertainty from the fact that each firm in the set of comparables has a different beta estimate. Again, standard statistical techniques are available to quantify this uncertainty. NERA shows that the standard statistical range extends above 0.5. NERA questions (p. 28) why the consultants' report "does not provide any details on why it has estimated a 'feasible range' that is inconsistent with its own estimates of comparable historical proxy betas."

Moreover, the consultants' report also completely ignores the much greater estimation error inherent in the estimation of each individual beta.

Further, there is uncertainty surrounding the estimation of parameters that are used to unlever estimated equity betas into asset betas. As one example, the Authority recognizes two approaches to estimating the debt beta--reverse-engineering from the CAPM and setting the debt beta to zero. Thus, the Authority defines 0 - 0.22 to be an economically reasonable range. These different values can result in a 27% difference in estimated asset betas. Consider an estimated equity beta of 1.0 and other parameters fixed at the values used in the Draft Determination. If the debt beta is set at 0, the asset beta is estimated at 0.44. With a debt beta of 0.22, however, the asset beta is estimated at 0.56.

The consultants' report assumes a debt beta of 0.1 throughout. There is no consideration of the effect that uncertainty about this estimate may have on the estimated asset beta—even if we pretend that equity betas are precisely measured and that the set of comparables is appropriate.

Moreover, the unlevering procedure also depends, indirectly, on the value of franking credits (gamma) and market risk premium. No one would begin to suggest that the Authority's estimates of 0.5 and 6% respectively, are statistically precise. Indeed there appear to be some inconsistencies in the Draft Determination in relation to the very definition of these parameters.

The conclusion from this discussion is that the data that forms the basis of the consultants' report is statistically imprecise. Standard statistical confidence intervals would be very wide indeed. Setting a range as narrow as 0.3 - 0.4 cannot be justified from the available data given the various sources and magnitude of statistical precision.

However, some degree of pragmatism is required in the regulatory setting. This requires an examination of regulatory precedent and considerations of common sense. In regard to regulatory precedent, the NERA report provides the following information:

[7] National Economic Research Associates. (2004). Critique of the proxy betas of Dalrymple Bay Coal Terminal: A draft report for Prime Infrastructure.

Table 2: Summary of Regulatory Determinations: Ports

	Debt Beta = 0.10		Debt Beta = 0.20
Company/Sector/Decision	**1997-99**	**2001-03**	**1997-99**
Port sector:			
NZ and UK ports	0.63	0.45	
Port regulatory decisions:			
Melbourne Ports Corporation			0.60
(ORG June 2000)			
Victorian Channels Authority			0.50
(ORG June 2000)			

Table 3: Summary of Port Beta Estimates

	Asset Beta of NZ Ports	
Company	**1997-99**	**2001-03**
Lyttelton Port	0.98	0.63
Northland Port	0.86	0.78
Port of Tauranga	0.34	0.28
Port of Auckland	0.70	0.49
South Port of New Zealand	0.64	0.47
Mean of NZ ports	0.70	0.53

Table 4: Recent Regulatory Decisions

Decision	**Equity Beta**	**Asset Beta***
TransGrid NSW (2000)	1.02	0.50
Powerlink Qld (2001)	1.00	0.50
ElectraNet SA (2002)	1.00	0.50
SPI PowerNet Vic (2002)	1.00	0.50
Transend Tas (2003)	1.00	0.50
QCA Gas distributions	1.12[15]	0.55
QCA DNSPs (2001)	0.90[18]	0.45
QCA Rail** (1999)	0.76	0.42

*Assuming a debt beta of 0.1. **The assumed gearing level is 55%

The conclusions that can be drawn from this analysis are as follows:

- The asset betas for infrastructure businesses that have been used in recent Australian regulatory determinations uniformly exceed 0.4, with most being 0.5 or above.
- The asset betas used in other port determinations are uniformly above 0.4, with most being 0.5 or above.
- The asset betas of NZ ports varies considerably, with the Port of Tauranga being the only one with an asset beta consistently below 0.5.

Of course, it is possible to argue about which firms and which determinations are most comparable, but that inevitably leads to a very small and controversial set of firms. The result of this is such a high degree of estimation uncertainty that the resulting estimates are essentially unusable.

For these reasons, we propose a minimalist approach. Our approach is to specify an economically reasonable range for each parameter, rather than choosing a specific point estimate. Given the weight of evidence and the statistical uncertainty, it is impossible to state that an asset beta of 0.5 is outside the range that is considered to be economically plausible.

For this reason, we propose a range of 0.3 – 0.5 for the asset beta. That is, the submission of the User Group and the low point of the range submitted by the Authority's consultants is within, but at the lower end of, the range that is economically plausible. At the upper end, the weight of evidence suggests that an asset beta of 0.5 certainly cannot be considered economically implausible.

MARKET RISK PREMIUM

The Authority, as with many other Australian regulatory bodies, adopts a consistent approach to its estimation of the market risk premium. In each of its recent determinations, a market risk premium of 6% has been adopted. This decision has been based primarily on historical data, although the Authority has also considered survey data, market practice, and academic studies that discuss the link between volatility and the MRP (without establishing or quantifying this empirically)[8]. The Authority has not stated how it has weighted the various pieces of evidence, which it finds most persuasive, or why. In the Draft Determination, the Authority recognizes (p. 184) that none of the approaches that have been used to estimate the MRP produce a robust and definitive point estimate. The Authority states (p. 184) that, "all of these considerations point to examining estimates from a range of approaches. The Authority has used a market risk premium of 6% in previous decisions, and the results from the available estimation methodologies suggest that this figure is reasonable". That is, the Authority concludes that the available evidence is not sufficiently precise to warrant a change from its previous estimate of 6%. The Authority would not contend that 6% is a precise statistical estimate—it is clearly an imprecise estimate at best. We propose that this uncertainty and imprecision should be recognized and quantified. The standard way of doing this is via the framework that has been developed over many years in the field of statistics.

The Central Limit Theorem of statistics documents that, in a large sample, the estimate of the mean is normally distributed around the true mean. The 120-year sample of historical equity returns relative to the risk-free rate has a mean of 6.5% and the standard error around the mean is 1.8%. Depending on the time period of data that is used, the mean estimate of the market risk premium could be anywhere between 6% and 8%.[9] Given the regulatory precedent for the use of 6.0%, and the lack of any statistically significant difference between this value and the sample mean of 6.5%, we propose a

[8] DBCT Draft Determination, p. 184.

[9] Even smaller values are obtained from using very short periods of data, but these estimates are extremely imprecise and are characterised by very large standard errors.

market risk premium centred around 6%, but that the appropriate statistical measure of uncertainty also be recognized.

Specifically, we propose that the market risk premium be modelled as normally distributed with a mean of 6.0% and standard deviation of 1.8%. In addition, we propose that the distribution be truncated at the 5^{th} and 95^{th} percentiles, (3.04% and 8.95%, respectively). This is done in order to prevent simulated values for the market risk premium being negative, implying an expected return less than the risk free rate, or being a very low number, which results in unreasonably high debt betas if the CAPM reverse-engineering process is used.

TAX RATE

We fix the tax rate to 30%, as in the Draft Determination. We note that this parameter has only a minor effect on the WACC, via the re-levering equation adopted by the Authority.

VALUE OF FRANKING CREDITS, GAMMA

The appropriate value of gamma remains a controversial and unresolved issue. Many issues could be raised in relation to the Authority's treatment of this issue in the Draft Determination. However, this would confuse the issues of parameter estimation (or definition) and the proper assessment of estimation uncertainty. Moreover, gamma has only a minor effect on the WACC, via the relevering equation adopted by the Authority. For this reason, we fix $\gamma = 0.5$ for our analysis, consistent with the value proposed in the Draft Determination.

DEBT BETA

The Authority considers two procedures for computing the debt beta. One approach is to set the debt beta equal to zero. The other is to reverse-engineer an estimate of the debt beta from the CAPM. This is done by dividing the debt margin by the MRP. These two approaches are used to set the economically plausible range for this parameter.

An upper bound for the debt beta is computed by reverse-engineering the CAPM. In particular, this value is computed by dividing the debt margin by the market risk premium (where each of these quantities have been drawn from their respective distributions). We then draw a debt beta from the range bounded by zero and the upper bound that has just been computed.

SIMULATION FRAMEWORK

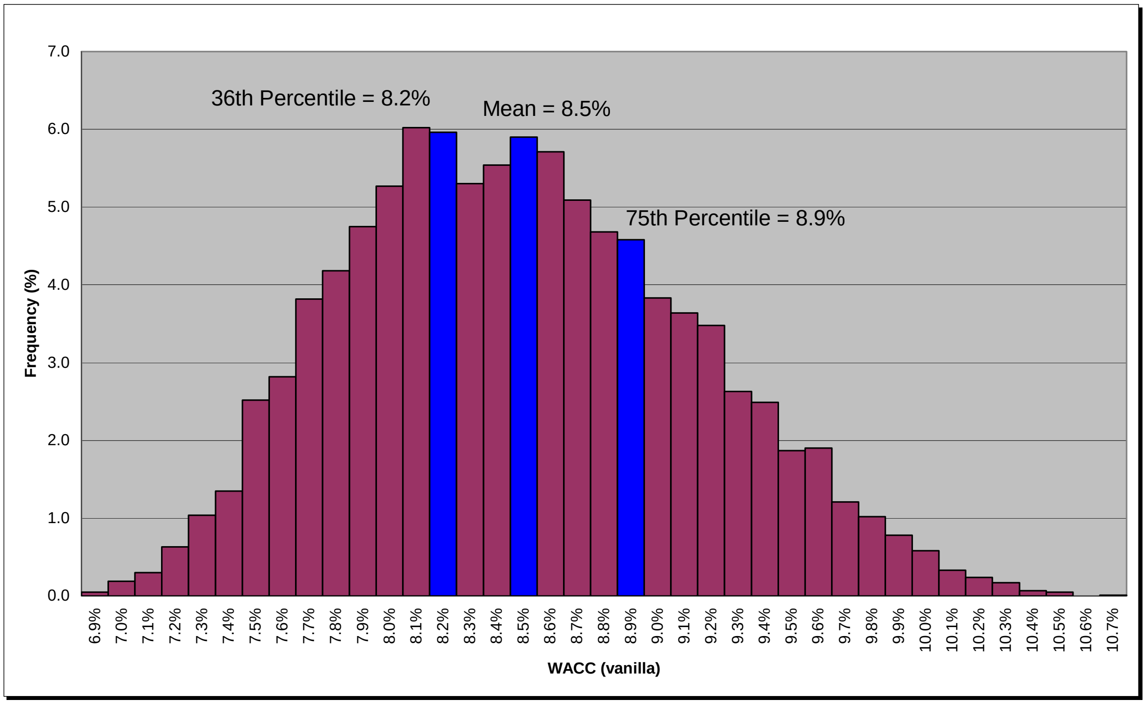
In our analysis, we hold the risk-free rate, gearing, corporate tax rate, and value of franking credits fixed at their prescribed values.

We then draw values for market risk premium, asset beta, and debt margin from their respective probability distributions, reflecting the uncertainty with which they are estimated.

At this stage, we have values for all of the WACC parameters. We then mechanically compute the nominal post-tax vanilla WACC.

This process is repeated 10,000 times yielding a histogram of WACC estimates, which is illustrated in Figure 1 below.

Figure 1: Distribution of vanilla post-tax nominal WACC estimates for 10,000 simulations



The result of this procedure is a mean WACC estimate of 8.5% with a standard deviation of 0.6%. There is a 50% chance that the true cost of funds is between 8.0 and 8.9%. **There is a 36% chance that the true cost of funds is 8.2% or lower.**

Figure 1 should be interpreted as a probability distribution of the firm's true cost of funds (vanilla post-tax WACC). That is, the true asset beta is assumed to be between 0.3 and 0.5, the true market risk premium is assumed to come from a normal distribution with mean 6% and standard deviation 1.8%, and so on. This all aggregates up to a probability distribution for the firm's true cost of funds.

At this stage, it should be noted that the proposed approach involves nothing new. All Australian regulators recognize that there is uncertainty involved in estimating several WACC parameters. It is also quite standard to recognize this uncertainty by assigning a reasonable range for these parameters. The proposed approach simply uses standard statistical techniques to produce a full probability distribution for the WACC of an efficient benchmark firm in a manner that is entirely consistent with the parameter ranges that have been specified for the uncertain WACC parameters. This provides the regulator with a useful additional tool—the ability to explicitly measure the probability that a particular regulatory (allowed) WACC will be insufficient to meet the cost of funds of an efficient benchmark firm. This information will be useful to the regulator in setting an allowed return to balance (i) whether the costs paid by consumers are higher than they need to be, with (ii) whether the returns earned are sufficient to ensure the viability of the regulated entity and provide the appropriate incentives for future investment. Clearly, a key piece of information to be considered by the regulator when assessing these competing objectives is the probability that the allowed WACC will be insufficient to meet the true cost of funds. This, of course, is directly related to the ongoing viability of the business and to the incentives for future investment. This non-recovery probability would be set at 50% if these two considerations were ranked equally. But they are not. Setting the non-recovery probability at 25% for example, would reflect the fact that it is more important to ensure the viability of the business than to ensure that customers pay the minimum possible cost.

The following section explores the appropriate probability of the regulated entity being unable to meet its cost of funds—what is an acceptable probability that the return allowed by the regulator threatens the viability of the business and future investment? Our conclusion on this point is that the regulatory WACC should be set so that there is at least a 75% chance that it will be sufficient to cover the true cost of funds of the benchmark entity. Figure 1 shows that a regulatory WACC of 8.9% would provide this level of confidence to the regulated businesses.

That is, given the uncertainty surrounding the estimates of key WACC parameters, and the interaction between parameters, a regulatory WACC of at least 8.9% is required to provide Prime Infrastructure with a return that is sufficiently likely to meet the cost of funds so as not to threaten the long-term viability of the business or to provide a disincentive for future investment.

2.3. CONSERVATISM OF PARAMETER RANGES

The above analysis above is based primarily on ACG data used by the Authority in reaching its Draft Decision on an appropriate WACC for DBCT. This results in a conservative probability distribution for WACC as:

- An MRP of 6.0% has been used, despite there being evidence of higher mean MRP estimates of between 6 and 8 % based on empirical studies; and
- An asset beta range of 0.30-0.50 has been used but if ports data provided by NERA was to be used, the range would be 0.30 – 0.70, or 0.30-0.55 could be used based on recent regulatory decisions.

There is, therefore, arguable scope to widen the range of estimates for each of the parameters used in CAPM. The resulting mean WACC would be significantly higher than the estimate in 2.2 above.

3. THE PROBABILITY THAT THE REGULATED ENTITY WILL EARN A RETURN THAT IS NOT SUFFICIENT TO MEET ITS COST OF FUNDS

Thus far, we have established that the regulatory WACC is an *estimate* of the entity's cost of funds. It is computed as the aggregation of a number of parameter estimates where some of these parameters are estimated with considerable estimation error. The entity's true cost of funds might be more or less than the regulator's estimate.

This is generally recognised by Australian regulators. For example, the Essential Services Commission states in the *2003 Gas Distribution Review (Final Report)* p. 313, that "unlike the price for most goods and services, the market price for investment capital cannot be observed. Rather it needs to be *estimated* from information available from the capital markets. It is important to note that neither the company, the regulator nor customers can determine the cost of capital—it is a market price for investment funds that can only be inferred from the available evidence."

To assist the regulator to balance competing objectives, we have illustrated a technique that produces a full probability distribution for the true cost of funds of an efficient benchmark entity. This probability distribution is entirely consistent with the uncertainty surrounding individual WACC parameter estimates. It also enables the regulator to compute the probability that a particular regulatory allowed WACC is insufficient to meet the cost of funds of an efficient benchmark entity.

In this section, we propose that the regulatory WACC should be set so that there is at least a 75% chance that it is sufficient to meet the true cost of funds. This is based on the asymmetry in the consequences of erring on this matter. If the entity fails to earn a return that is at least equal to its cost of funds, there are implications for the ongoing viability of the entity and for future investment. These consequences can be severe, given that it is essential basic infrastructure business that are regulated. This regulatory risk must be balanced against the prices paid by consumers. There is a trade-off between price on the one hand and service and guaranteed supply on the other. Setting a 75% probability of being able to earn a return sufficient to cover the true cost of funds is consistent with the notion that ensuring the ongoing viability of the business and creating the right incentives for future investment is more important than keeping prices to a minimum, a view that is supported by the Productivity Commission. Note that if consumer prices and business viability are weighted equally, there is a 50% chance that the WACC will be insufficient to cover the entity's cost of funds.

The proposed approach provides a framework for quantifying the trade-off between costs and service standards—if prices (and returns) are to be lowered, how (quantitatively) will this impact the ability of the firm to meet its cost of funds and provide adequate returns to its investors?

Moreover, there are relatively long lead times for investment in port infrastructure. This reinforces the argument in favour of allowing a regulated business a better than even chance of earning their cost of funds. If the regulatory WACC is set too low, there is a significant chance that the firm will be unable to recover its cost of funds. In practice, firms invest only when there is a relatively high probability of the investment earning a return that exceeds the cost of funds. Much of the evidence of this is reviewed below. Thus, a low regulatory WACC provides a disincentive for future investment. In addition, realized returns in the current period can be increased (perhaps enough to cover the cost of funds) by underspending against scheduled CAPEX. In both cases, the result is underinvestment in port infrastructure. Of course, this can be corrected in future periods if the regulatory WACC is increased, realised returns are increased, or by external injection of funds. The problem with this approach, of course, is that there are significant lead times involved. The Queensland electricity distribution businesses, for example, are currently having difficulty obtaining the required infrastructure and skill base to implement a significant increase in CAPEX spending. These factors are particularly relevant as "The Authority must have regard to the access provider's legitimate business interests and investment in the facility; in addition to, the public interest, including the benefit to the public in having competitive markets; and the economic value to the access provider of any extensions to, or other additional investment in, the facility that the access provider or access seeker has undertaken or agreed to undertake."[10]

Conversely, the regulatory WACC may be set so that there is a better than even chance of the entity recovering its cost of funds. Some would argue that in this case there is an incentive for firms to over-invest in CAPEX. However this is a much less severe problem for three reasons. First, the DBCT User Group is involved in all decisions about substantial new investment at the port. Moreover, it is well-known that expansion of the DBCT port facilities will be required in the short-term. Second, the regulator approves prudent CAPEX. Any overspend will not (initially at least) generate any return on capital for the firm. Third, any CAPEX spending that really is beyond requirements is not simply waste. With a growing demand for port infrastructure, this additional CAPEX would eventually be required. That is, the issue is simply one of timing—was the CAPEX really required today, or could it have waited for a year or two? Thus, the effects of CAPEX overspending are minor, relative to CAPEX underspending. In one case, investment earns a return for a year or two longer than it should have. In the other case, underspending causes backlogs and the flow-on effects for the users, their employees, and the economic reputation of the state. The aggregate welfare effects are much more severe in this case.

This issue has recently been addressed in some detail by the Productivity Commission (PC), the Supreme Court of Western Australia and the Australian Competition Tribunal. For example, the Productivity Commission's Review of the National Access Regime recognises that the effects of too little infrastructure investment are far more severe than those associated with too much (or too early) investment. The PC states (p. xxii) that "Given that precision is not possible, access arrangements should encourage regulators to lean more towards facilitating investment than short term consumption of services when setting terms and conditions" and that "given the asymmetry in the costs of under- and over-compensation of facility owners, together with the informational uncertainties facing regulators, there is a strong in principle case to 'err' on the side of investors".

The PC goes on to quote from a submission to the review by NECG, which stated that "In using their discretion, regulators effectively face a choice between (i) erring on the side of lower access prices and seeking to ensure they remove any potential for monopoly rents and the consequent allocative inefficiencies from the system; or (ii) allowing higher access prices so as to ensure that sufficient incentives for efficient investment are retained, with the consequent productive and dynamic efficiencies such investment engenders. There are strong economic reasons in many regulated industries to place particular emphasis on ensuring the incentives are maintained for efficient investment and for continued productivity increases. The dynamic and productive efficiency costs associated with distorted incentives and with slower growth in productivity are almost always likely to outweigh any allocative efficiency losses associated with above-cost pricing. (sub. 39, p. 16)"

The PC Review highlighted the need to modify implementation of the regime and made 33 recommendations to improve its operation. In particular it identified as a "threshold issue, the need for the application of the regime to give proper regard to investment issues" and "the need to provide appropriate incentives for investment."

This view is supported by the Commonwealth Government, which has resolved to amend the Trade Practices Act in this regard. In particular, the access regime will be modified to include a clear objects clause: "The objective of this part is to promote the economically efficient operation and use

[10] Queensland Competition Authority Act 1997, Part 5, s120.

of, and investment in, essential infrastructure services thereby promoting effective competition in upstream and downstream markets…"

In addition, a set of pricing principles will be included that requires "that regulated access prices should: (i) be set so as to generate expected revenue for a regulated service or services that is at least sufficient to meet the efficient costs of providing access to the regulated service or services; and (ii) include a return on investment commensurate with the regulatory and commercial risks involved…"

We argue that these views are consistent with the notion that the regulatory WACC should be set so that there is a better than even chance of the entity recovering its cost of funds.

In the remainder of this section, we examine commercial practice in this regard. In particular, we examine whether firms make investment decisions based on an estimate of WACC, or whether they use a hurdle rate that exceeds the estimated WACC to ensure that there is a better than even chance of the investment producing a return above the cost of funds and therefore creating shareholder value.

Many studies have investigated the relationship between companies' cost of capital and the hurdle rate they use in investment decisions. Generally, these studies have found that the hurdle rates used are significantly above the firm's cost of capital: on average, at least 5 percent higher. This finding is now well established within the literature, and more recent research has attempted to investigate the reasons for this. The discussion below reviews studies that investigate the difference between hurdle rates and cost of capital, their methodologies and findings, and where relevant, any proposed explanation for the phenomenon.

3.1. SUMMERS (1987)

The most widely cited study examining hurdle rates is that of Summers (1987). The purpose of his study was twofold. First, to establish the theoretical discount rate that should be used to discount depreciation allowances. Second, to compare this rate to the actual discount rate being used by managers in the largest firms in the US.

In the first section of the paper, Summers argues that in the context of an investment project, the tax deductions relating to depreciation should be discounted separately from the operating cash flows of the project, as the depreciation deduction will essentially be risk-free, whereas the cash flows from the project will generally be risky. Consequently, the rate that should be used to discount tax depreciation is the yield on Treasuries, which at the time of the study was about 8-9 percent. Given a corporate tax rate at the time of 46 percent, Summers concluded that a nominal rate of less than 5 percent was appropriate as a discount rate. Based on the inflation rate at the time, the real discount rate implied was close to zero.

The author then surveyed the Chief Financial Officers of the top 200 Fortune 500 companies in the U.S. (obtaining 95 useable responses), in order to investigate companies' actual capital budgeting policies. More specifically, the questionnaire asked the managers to report hurdle rates for an average project, and whether different discount rates were used for projects with different risk profiles. The most common response received was that the same rate was used to discount all cash flows from a particular project. The hurdle rates employed ranged between 8 and 30 percent, with a mean of 17 percent.

While Summers did not directly compare the hurdle rates observed with cost of capital (as the study focused on the discount rate for depreciation tax deductions), his results can be compared with two studies around the same time which looked at companies' theoretical cost of capital. Kaplan (1986) argued that the real cost of capital for an average business was around 8 percent. Samuels and Wilkes

(1986) suggested that the real discount rate should be 7 percent. Therefore, even assuming a long term inflation rate of between 4 and 5 percent, which is probably too high, it could be concluded on the basis of Summers' study that the hurdle rates used are 4 to 5 percent higher than the firm's cost of capital. This finding is consistent with a later study carried out by Poterba and Summers (1995), which is described below.

3.2. POTERBA AND SUMMERS (1995)

A second important U.S. study conducted in this area was that done by Poterba and Summers (1995). The purpose of their paper was to determine if a difference existed between hurdle rates and capital costs, and examine the implications of any difference in terms of the investment horizons of U.S. firms.

The authors sent a survey of questions relating to capital budgeting and investment decisions to the CEOs of Fortune 1,000 companies in the U.S., and received 228 useable responses. The most relevant question asked in the survey, in terms of this review, was one which asked respondents to report the hurdle rate that they would employ to discount cash flows on a typical project in the firm's largest division. Most of the responses were in the form of nominal rates, which the authors converted to real rates using an expected long-term inflation rate of 5 percent. This yielded a real hurdle rate of 12.2 percent for the entire sample, and slightly lower (11.6 percent) for manufacturing firms only. They compared this figure to average realized real returns on debt and equity since the 1920's, and found them to be significantly lower, at about 2 and 7 percent respectively. Therefore, even if firms were assumed to be 100 percent equity financed, which of course is unrealistic, the hurdle rate employed will still be 5 percent higher than the firm's cost of capital.

The authors did not explore the reasons for the difference between hurdle rates and cost of capital in any great detail. They suggested, in passing, that it may be due to overly optimistic cash flow forecasts on possible projects.

3.3. OTHER U.S. AND U.K. SURVEY EVIDENCE

There have been many other surveys conducted in relation to hurdle rates in both the US and the UK. In terms of techniques used to evaluate investment opportunities, Kennedy and Sudgeon (1986) surveyed firms in both the U.S. and U.K. and found that the most common method of project evaluation used in firms within the sample was to add a premium to the cost of capital.

A significant number of other studies have attempted to quantify the hurdle rates used by firms, in a similar manner to Summers (1987) and Poterba and Summers (1995). The most significant U.K. study carried out in this area was done by the Confederation of British Industry (CBI) and the Association of Consulting Actuaries' (ACA). The organizations surveyed 326 of the largest listed companies in the U.K. This research found that the average hurdle rate being used by firm's was 17.1 percent, whereas the cost of capital was around 11.9 percent. Waites (1998), in interpreting these survey results, argued that the high hurdle rates could be linked to a generalized allowance for risk.

Scapens and Sale (1981) surveyed 300 Financial Times 1,000 companies in the U.K. and 227 Fortune 500 companies in the US. From these surveys, they concluded that the average hurdle rates being employed in the U.K. and U.S. were 18.5 and 17.1 percent respectively, with some companies reporting hurdle rates up to 40 percent. Woods et al (1985) found an average hurdle rate of 23.7 percent, and Fotsch (1983) reported an average rate of 25 percent. If these results are compared to the cost of capital figures reported by Kaplan (1986) and Samuels and Wilkes (1986) of 8 and 7 percent, the hurdle rates are again found to be significantly higher: of the order of at least 5 percent[11].

3.4. DIEDEREN, VAN TONGEREN AND VAN DER VEEN (2003)

Diederen et al used a different methodology to investigate the differences between company hurdle rates and actual cost of capital. The study began by making an observation in relation to the adoption of two new technologies: they stated that whilst these technologies should be adopted by more than 90 percent of firms in the industry on the basis of NPV calculations, the adoption rate was much lower (49% for one of the technological improvements, and 79% for the other).

The authors then attempted to predict the hurdle rate used by firms. Their predicted hurdle rate was, on average, 1.76 times the ordinary cost of capital. The study found that this model had significant power in terms of explaining the decision to invest of firms in the sample. They suggested that the reason for the discrepancy was the uncertainty in future energy prices, which they incorporated into their model.

3.5. OTHER EXPLANATIONS FOR THE DISCREPANCY

A variety of studies have put forward other suggestions for observed high hurdle rates such as the value of an option to wait to invest (Purvis et al 1995 and Diederen et al 2003); overcoming managerial incentives to over-invest (Antle and Eppen 1985 and Antle and Fellingham 1990); market imperfections (DeCanio 1998); high transaction costs in relation to adopting new technology (Fagundes de Almeida 1998) and uncertainty about future technological developments (Grenadier and Weiss 1997). This indicates that there is no single specific reason for the use of high hurdle rates, but that some form of uncertainty is central to any explanation.

3.6. SUMMARY

The literature reviewed above illustrates two key points. First, there is considerable evidence to show that companies in both the U.S. and U.K. use hurdle rates that substantially exceed their cost of capital in order to evaluate potential investment opportunities. Second, the reason for the observed discrepancy between hurdle rates and cost of capital has not been resolved, but uncertainty is a key element of any explanation.

This result is consistent with firms developing corporate investment policies to ensure that an investment will only proceed if there is a significantly higher than 50/50 chance that the investment will recover the cost of funds. The implication in this context is that a regulatory WACC set such that there is a 50/50 chance of it being high enough to cover the entity's true cost of funds is inconsistent with corporate practice and insufficient to attract the required levels of new investment.

Finally, the magnitude of the difference between corporate cost of capital and estimated WACC suggests that firms are reluctant to invest unless there is a better than 75% chance that the investment will generate a return of at least its cost of capital. In fact, this magnitude suggests that firms are unlikely to invest unless the investment is highly likely to generate a return in excess of the cost of funds. In this respect, setting this probability at 75% appears to be conservative.

We conclude that it is appropriate for the Authority to set the post-tax nominal vanilla WACC at 8.9% or above.

[11] That is, once the hurdle rates have been adjusted for inflation.

4. EXTRAORDINARY EVENTS AND ASYMETRIC RISK

Finally, we note that this report does not address asymmetric risks or extraordinary events—non-systematic risk of a significant loss. These asymmetric risks require an adjustment to the cash flows or the discount rate. That is, the proposed WACC will imply certain price or revenue targets which must be adjusted to account for asymmetric risk. Alternatively, for pragmatic reasons the regulated business and regulator may favour an increase to the regulated WACC to compensate for asymmetric risk. Neither of these adjustments is specifically addressed in this report

5. INCORPORATING THE RELATIONSHIP BETWEEN MRP AND GAMMA

The foregoing analysis assumes that the Authority's estimate of 6% for the market risk premium incorporates its estimate of the value of franking credits. That is, the MRP is an estimate of the return that a broadly diversified shareholder in the Australian market would expect to receive, on average, in excess of the long-term government bond yield. The return to shareholders has three components that are potentially valuable – dividends, capital gains, and franking credits.

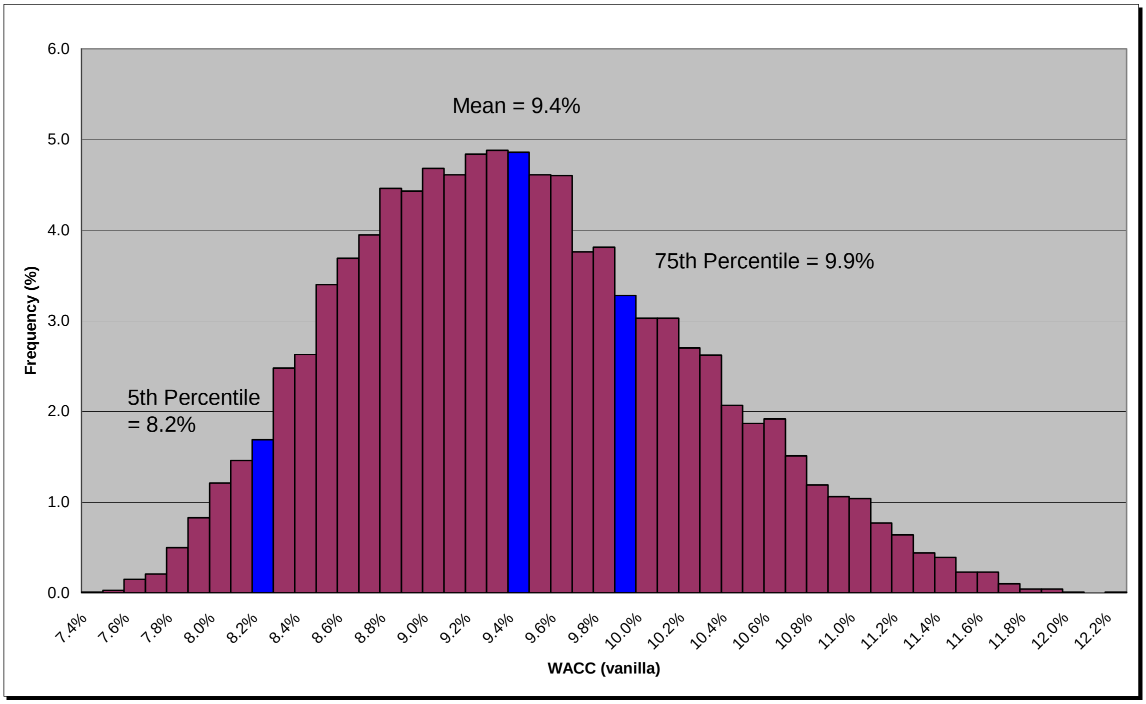
The Authority has provided a separate estimate of the value of franking credits, setting gamma equal to 0.5. This leaves the value of dividends and capital gains to be estimated. That is, what would the MRP be, in the absence of franking credits? The Authority has estimated this by examining historical data on dividends and capital gains from the Australian market – franking credits are ignored in these data sets. The Authority also examines evidence from other developed equity markets, which also ignores franking credits (indeed most other markets do not have an imputation system like that in Australia). Finally, the Authority examines evidence from surveys in which participants are asked to forecast the level of a benchmark index at some time in the future (i.e., franking credits are ignored here as well).

That is, all of the evidence that the Authority cites as support for its estimate of MRP relates to dividends and capital gains only – franking credits are ignored. Thus, to the extent that the Authority assumes a positive value for franking credits, this value should be added to the estimate of the MRP that comes from dividends and capital gains only. In the foregoing analysis, we have ignored this important relationship between MRP and gamma and assumed that the Authority's estimate of 6% incorporates its estimate of the value of franking credits. We note that this implies that dividends and capital gains provide a MRP of only 3.9%, in contrast to the Authority's evidence suggesting that 6% is appropriate. Nevertheless, the analysis above assumes that the Authority's estimate of 6% includes its estimate of the value of franking credits.

If, however, we consider the 6% MRP estimate to reflect dividends and capital gains only (consistent with the empirical evidence on which that estimate is based) we must add the Authority's estimate of the value of franking credits to this estimate of MRP. We have extended our analysis to incorporate the value of franking credits in the manner prescribed by Officer (1994, pp. 8-10).[12] The results of this analysis are illustrated in Figure 2.

[12] This is the same paper as that which forms the basis of the Authority's process for computing return on capital.

Figure 2: Distribution of vanilla post-tax nominal WACC estimates for 10,000 simulations – incorporating the link between MRP and gamma



The result of this procedure is a mean WACC estimate of 9.4%, with standard deviation of 0.8%. There is a 50% chance that the true cost of funds is between 8.8 and 9.9%. **There is a 5% chance that the true cost of funds is 8.2% or lower.**

If the value of franking credits is to be added to the Authority's estimate of MRP, a regulatory WACC of 9.9% provides a 75% chance of being able to recover the true cost of funds.

We conclude that if the Authority's estimate of MRP is adjusted to incorporate its estimate of the value of franking credits (in the manner prescribed by Officer, 1994) is it is appropriate for the Authority to set the post-tax nominal vanilla WACC at 9.9% or above in order to provide Prime Infrastructure with a 75% chance of being able to recover its cost of funds.

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