QUEENSLAND COMPETITION AUTHORITY

Working Paper 4

Issues in the Estimation of Queensland Rail's Below Rail Coal Network Expected Rate of Return

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Queensland Competition Authority
Level 19, 12 Creek Street *Tel: (07) 3222 0555*
GPO Box 2257 *Fax: (07) 3222 0599*
Brisbane QLD 4001 *Internet: www.qca.org.au*

1. INTRODUCTION

The rate of return is the return expected by investors in capital markets for investments of a given level of risk. It is a forward-looking concept based on estimated future expected returns and future expected risk. The rate of return is, essentially, the opportunity cost to investors to compensate them for the expected returns on foregone investment opportunities (that is the expected return on the next best alternative asset).

In competitive capital markets, the rate of return is determined by the forces of supply and demand for capital. Accordingly the rate of return should provide a rate of return to investors that is commensurate with the returns available from other assets. It should be set at a level that is equal to the cost of attracting capital to a particular asset.

An inappropriate rate of return for QR's rail transport infrastructure may result in over or under investment in rail infrastructure and distort prices to end users of commodities delivered via the network. For example:

- if too high a rate of return is set, QR would be encouraged to invest in the network to an excessive extent and shippers would be required to pay too much for using the network, undermining the competitiveness of industries reliant upon QR; and

- if too low a rate of return is set, QR would not be adequately compensated for its investment. Whilst this would lower prices in the short term, QR would be unlikely to undertake further investment in the network, leading to congestion and an inability of shippers to deliver their product to their market in the longer term.

The method used to determine the rate of return on QR's rail transport infrastructure should encourage efficiency in the operation of the regulated business and shield those seeking access from the cost of inefficient financing decisions. It is also important that the rate of return does not induce any resource allocation distortions between the private and public sectors.

Hence the identification of an appropriate rate of return is central to the setting of maximum prices for rail access charges that encourage efficient usage of the network and efficient levels of future investment in network assets in the medium to long term.

The calculation of an appropriate rate of return should not be performed with the rigid adherence to a particular conceptual financial model. But rather the rate of return should reflect discretion and judgement based on realistic, commercial experience and understanding.

This working paper develops as follows:

- section 2 assesses the general method to be applied to estimate the rate of return for QR's below rail coal business;

- section 3 contains an overview of QR and assesses whether the rate of return should be segment-specific or QR-wide;

- section 4 identifies the parameters needed for the estimation of the rate of return in the WACC / CAPM framework and discusses alternative methods for the calculation of WACC; and

- section 5 estimates the rate of return for QR's below rail coal network using the parameters established in section 4.

2. RATE OF RETURN ESTIMATION

A firm's WACC recognises that its capital is provided by two sources, namely lenders and equity investors (that is owners or shareholders), and is equivalent to the weighted average cost of servicing the various classes of financial claims on the firm.[1] Each source of capital or financial claim will involve different risks and hence different costs. A firm's WACC is calculated by adding the cost of its debt, weighted by the proportion of debt to total assets, to the cost of equity funds weighted by the proportion of equity funds to total assets. The methodology requires estimates of the current market values of the firm's debt and equity and market rates for both sources of funds.

Subject to how cash flows are defined, alternative approaches can be taken to estimate WACC. Inconsistency between the measured cash flow and the approach to assessing the WACC will result in errors in the valuation process. Provided cash flows are expressed as the levered cash flow available to service debt and equity, after allowing for the tax deductibility of interest and the value of any imputation tax credits, the post-tax WACC for an entity (assuming that taxation and allowances for dividend imputation credits are included in the entity's cash flows) can then be calculated as follows:[2]

$$WACC_{posttax} = R_{equity}\frac{E}{V} + R_{debt}\frac{D}{V}$$

where

R_{equity} = the return on equity (the cost of equity)

R_{debt} = the return on debt (the cost of debt)

V = the total market value of the firm

E = the market value of the equity

D = the market value of the debt

The cost of retaining and attracting equity funds is not observable for a government owned corporation such as QR because it is not listed on a stock exchange. Consequently, its cost of equity needs to be estimated using data from security markets.

A number of alternative models have been developed to estimate the cost of equity funds, including the:

- Capital Asset Pricing Model (CAPM) which determines the return on equity using a single risk factor (known as beta, β) related to market return. Basically, the total risk of a business activity can be separated into diversifiable and undiversifiable risk;[3]

- price/earnings (P/E) ratio, which involves capitalising the estimated future maintainable earnings of the business at a multiple appropriate to the risks and prospects of the business to calculate a value for the business;

[1] Equity securities offer shared ownership of the entity for their shareholders who obtain their return from equity in the form of capital appreciation (depreciation) caused by share price rises (falls) and through the receipt of dividends. In contrast debt holders provide loan capital with no associated claims on ownership and receive interest and repayment of the loan principal. Debt holders have senior claims to the entity's cash flows (and, in the case of liquidation, to the entity's assets) over equity holders.

[2] Alternative methods to calculate WACC and associated issues are discussed in Appendix E.

[3] Diversifiable risk is that risk that is effectively removed from holding a security as part of a wide (diversified) portfolio of assets. The remaining risk is known as undiversifiable risk which relates the correlation between the riskiness of a company compared to the market as a whole and is estimated by a linear regression based on historic data. The CAPM assumes that investors are only compensated for the undiversifiable risk associated with an investment. CAPM asserts that the market risk premium required per unit of undiversifiable risk is the same across all assets.

- dividend growth model, which is based upon the premise that the value of any asset is commensurate with the present value of the expected dividend stream from holding the asset. The cost of equity is assumed to be the discount rate which equates the current market value of the asset with the present value of the dividend stream; and

- arbitrage pricing theory (APT), which involves identifying macroeconomic factors affecting the asset and the risk premium for each of these factors.

However, the absence of directly comparable listed companies in Australia renders the application of the P/E ratio and dividend growth models relatively subjective in the context of assessing the QR's rate of return, even though it is recognised that both methods are widely used by practitioners. The APT model requires the identification and quantification of numerous risk factors that may affect the return on equity and is excessively subjective and selective.

In contrast, CAPM's popularity is chiefly due to its objectivity and simplicity. All Australian regulators apply the CAPM for this purpose so that the adoption of the approach offers considerable regulatory precedent. In addition, the CAPM is widely used by regulators in overseas jurisdictions.[4] Accordingly, the Authority proposes to use the WACC/CAPM approach to assess the rate of return for QR's below rail coal business.

However, there are theoretical and practical difficulties in implementing CAPM. From a theoretical perspective, CAPM is a single period model that assumes that all investors have a common time horizon of unspecified length. It therefore has difficulty capturing the multi-period nature of most investments.[5] As a result, it should be noted that the application of CAPM involves a certain degree of imprecision.

Practical limitations arise in the application of CAPM to government owned corporations for which there are often no directly comparable companies listed on a stock exchange. For example, the estimation of the equity beta (β_e) is not entirely objective and in practice, some judgement is required.

[4] For example, Ofgem (the Office of Gas and Electricity Markets), the UK electricity regulator, also used CAPM in its most recent regulatory decision with respect to electricity distribution. In contrast, the rail regulator in the United States of America utilises the Dividend Growth Model. However, the entities that are regulated are listed companies.

[5] See Gray, S. (1999), 'Response to Consultation Paper No 4: Cost of Capital Financing' which responded to Office of the Regulator-General, 1999, 'Consultation paper No 4: Cost of Capital'.

3. SEGMENT-SPECIFIC VERSUS QR-WIDE ANALYSIS

A critical issue involves whether the cost of capital should be calculated for QR's business as a whole or specifically for QR's coal traffics. QR's Draft Undertaking proposes that reference tariffs will only be developed for its coal services (at least initially).

3.1 Introduction to Queensland Rail

QR became a corporatised entity under the *Government Owned Corporations Act 1993* on 1 July 1995. QR is a provider of below rail and above rail services via a geographically widespread narrow gauge network of around 9,400 km. During 1999-2000, QR's network carried 131.5 million tonnes (Mt) of freight and catered for 43.4 million passenger journeys. Approximately 87 per cent of the freight carried was coal and around 98 per cent of the passenger journeys were in Brisbane's suburban rail network. This makes QR by far the largest rail operator in Australia, being almost twice as large as its nearest rival (FreightCorp). However, QR is a small railway by world standards, carrying about one-half of the freight of large US rail operators.[6]

QR provides almost all rail services in Queensland.[7] It employs in excess of 14,500 staff and has total assets of around $7.8 billion. Table 1 provides a summary of the traffic task undertaken by each of QR's major traffic groups in 1999-2000 (the most recent publicly available information). QR's coal and minerals services are important, both in terms of the freight task (90% by volume) and the revenues generated (80% of total sales revenue excluding government subsidies).

Table 1: QR Freight and passenger traffic task for 1999-2000

	Volume	**Change on 1999-00**	**Net tonne kilometres**	**Change on 1999-00**	**Average haul length**
	Net tonnes (M)	%	Billion kilometres	%	kilometres
Coal and Minerals Services					
Export Coal	104.5	11.1	25.3	11.2	242
Domestic Coal	9.9	-4.8	1.9	-13.6	192
Total Coal	**114.4**	**9.5**	**27.2**	**8.8**	
Minerals	7.5	1.4	1.7	6.2	223
Total Coal and Minerals	**121.9**	**8.9**	**28.9**	**8.6**	
General Freight	9.6	11.6	5.2	4.0	543
Total Coal & Minerals & General Freight	**131.5**	**9.1**	**34.1**	**7.9**	
	Journeys (M)		Passenger kilometres (M)		
Total Citytrain Services	42.4	3.2	889.2	7.5	21
Total Traveltrain Services	1.0	11.1	375.6	13.7	359
Total Passengers	**43.4**	**3.3**	**1,264.8**	**9.3**	

Source: QR Annual Report 1999-2000

6 The traditional measure of output for rail operators is net tonne kilometres (NTK) – in this respect QR's operation is less than one-tenth of the size of major US operators such as Burlington Northern Santa Fe.

7 Comalco Minerals & Alumina is a private rail owner/operator on the Weipa to Andoom line. In addition, there are a number of privately operated heritage train services in the State.

3.2 QR's coal network

Details of the Queensland coal industry and QR's coal network are in Appendix A and Table 2 respectively. QR's coal rail network currently comprises around 2000 km of track, about half of which is electrified. Computerised centralised traffic control operates over 1300 km of the network, with the remainder being operated under automatic signalling and (manual) train ordering.

Table 2: Details of QR's coal network

Coal rail system	Average train load (net tonnes)	Export tonnage (1999-00) Mt	Domestic tonnage (1999-00) Mt	Port	Type	Average haul distance (km)	Train trips per day (5)	Train trips per year (5)
Newlands	4,700	9.2	0.4	Abbot Point	Diesel	165	6	2,043
Goonyella	8,400 (3)	63.3	0.0	Hay Point & Dalrymple Bay	Electric	227	21	7,536
Blackwater	5,850 (4)	25.2	5.0	Gladstone (1) & Barney Point	Electric	315	14	5,034
Moura	3,200	4.6	4.1	Gladstone (1) & Barney Point	Diesel	155	8	2,719
West Moreton	1,800	2.1	0.3	Port of Brisbane (2)	Diesel	117	4	1,334

Source: Queensland Rail

Notes:

(1) RG Tanna terminal.

(2) Fisherman Island terminal

(3) The use of larger capacity rollingstock on the Goonyella line will raise this average over time to 9,000 net tonnes. At present, only a fraction of the trains consist of these new wagons.

(4) The use of larger capacity rollingstock o the Blackwater line will raise this average over time to 6,500 net tonnes. At present only a fraction of the trains consist of these new wagons.

(5) Train trips per day and train trips per year are approximations using average train load figures and export and domestic tonnages.

The Bowen Basin coalfields are serviced by four systems, all connected to the North Coast line. Two electrified systems (Goonyella and Blackwater) service the centre of the Bowen Basin and carry the bulk of Queensland's export coal (88.5 Mt of 104.4 Mt) to the Gladstone, Dalrymple Bay and Hay Point terminals. The two electrified systems are connected by a dedicated inland line. Two diesel systems service the northern and southern edges of the Bowen Basin (Newlands and Moura respectively). A diesel system services the West Moreton coalfields connecting the Surat Basin to the Port of Brisbane. During 1999-00, these corridors carried 15.9 Mt of export coal. All coal rail lines are narrow-gauge.

3.3 Segment-specific versus QR-wide rate of return

In practice, given the limitations of any risk pricing model (including the CAPM), there is an issue as to whether it is analytically possible to substantiate any difference between the risk of QR's below rail business generally and the risk of its below rail coal network.

The setting of reference tariffs, at least initially, will be restricted to below rail services provided to train operators on the coal network. Access charges in these areas will be expected to approach the upper bound of the floor/ceiling price range and consequently the rate of return becomes a major element in the determination of those charges. Not all access charges will be determined this way. For example, access charges for 'intermodal' traffics will instead be based on cost competitiveness relative to road transport.

An assessment of QR's business segments suggests that it is likely that the provision of infrastructure to service coal could involve a materially different risk profile relative to the provision of other traffics (for instance other freight and passenger traffic). As the WACC will only be relevant to coal traffics, at least initially, it would seem reasonable that its derivation be based on financial characteristics of QR's coal business. This is likely for the following reasons:

- QR's coal business is predominantly servicing the international coking and thermal coal markets. Typically, the market being served by the transport industry is within the domestic economy. Consequently, the earnings of transport industries are generally highly correlated with the phase of the domestic business cycle. However, QR's earnings from its below rail coal traffics are indirectly sourced from international coal users and are therefore not highly sensitive to changes in the domestic economy;

- in contrast to many other markets QR serves, QR's below rail coal network faces very low price risk and is not subject to competition from other transport modes; and

- QR's below rail coal network serves an industry operating predominantly at the bottom of the world cost curve and therefore has relatively low volume risk, especially given the regulatory arrangements that will apply to this activity.[8]

Accordingly, the Authority is inclined to the view that the rate of return should be based on the undiversifiable risk of QR's below rail coal network rather than focusing upon the undiversifiable risk associated with all of QR's below rail traffics.

[8] This will continue in the regulated environment via a take or pay element to access charges and a volume threshold above or below which will cause reference tariffs to be reviewed.

4. PARAMETER ESTIMATES FOR WACC

It is important to note at the outset that many issues associated with the implementation of the CAPM/WACC approach are intertwined and should not be considered in isolation. For example:

- the estimation of the cost of equity requires estimates of the risk-free rate, the market risk premium and the equity beta. The market risk premium is in part a function of the risk-free rate and the equity beta is a function of the entity's asset beta, debt beta and capital structure; and

- assumptions about the level of dividend imputation (gamma) can have an impact on the significance of the tax rate adopted. In the extreme, if gamma is assumed to be 1 (that is, all dividend imputation credits are recognised) then, subject to timing issues, tax ceases to be an issue altogether in the valuation process. In addition, as the recognition of imputation credits increases, the impact of an entity's capital structure on its WACC decreases.

CAPM determines the return on equity for an enterprise using a single risk factor related to market return. The central concept of CAPM is that of undiversifiable risk (known as beta. β). Basically, the total risk of a business activity can be separated into two distinct classes of risk, being undiversifiable and diversifiable risk. Undiversifiable risk is that risk which affects the market as a whole and relates to the correlation between the riskiness of an entity compared to the market as a whole. It can be calculated by a linear regression based on historic data.

The remaining risk is known as diversifiable risk. This risk can be removed by holding the security as part of a well diversified portfolio of assets. CAPM assumes that investors will not be compensated for the risk they can cost effectively avoid. This avoidable risk arises because the fluctuations in an investor's returns from holding a security can be ameliorated by holding that security as part of a portfolio of diversified investments. In other words, CAPM assumes that investors will only be compensated through the rate of return for the risk that cannot be avoided through diversification.

However, this is not to say that diversifiable risk is irrelevant for valuation purposes. This is because the rate of return (based on undiversifiable risk) is then applied to the organisation's expected cash flows. These expected cash flows can incorporate a range of scenarios reflecting diversifiable risks.

Beta is a statistical assessment of the degree of non-diversifiable risk associated with an asset or investment relative to the overall stock market. It assesses the systematic risk of the security, that is the risk that distinguishes it from the market as a whole. Since the beta of the market portfolio is 1, then all assets can be identified as being more or less risky than the market as a whole. For example, an enterprise with a beta of 1 has undiversifiable risk that is perfectly correlated with the expected return for the market as a whole.

The further a beta departs from 1 the more its returns are expected to vary from those of the market as a whole. A higher value of beta is associated with a more risky investment and a low beta is regarded as less risky than the market as a whole. In the extreme, an investment that does not vary at all with the market has a beta of zero.

CAPM states that assets should be priced such that the expected return from them is equal to the risk-free rate of return plus a premium for risk. The premium for risk is equal to the risk of the asset multiplied by the market risk premium, which in turn, is the difference between the return on the market as a whole and the risk-free rate. The relevant measure of risk in the CAPM framework is beta which is defined as the risk of an asset relative to the market as a whole or the covariance of the asset's return to the market return standardised by the variance of market returns. CAPM therefore seeks to incorporate into the equity beta for the asset the undiversifiable risks related to that asset's industry and operations. Therefore, given the risk-free rate, the equity beta of an asset and the overall market risk premium, the CAPM estimates the expected cost of equity funds for those assets.

However, an equity beta comprises an additional source of risk that arises from gearing. Because debt holders have senior claims to the entity's cash flows and assets, equity holders face an additional risk. This financial risk increases as the level of debt in the organisation's capital structure rises. CAPM assumes that a linear relationship exists between an entity's gearing and the financial risk associated with that gearing.

Therefore, there are two factors have been identified as key determinants of an entity's equity beta:

- asset risk arising from the entity's sensitivity to cash flow movements – relative to overall economic activity, where more cyclical cash flows are associated with higher betas; and

- financial risk arising from financial leverage – the ratio of debt to equity, where a higher level of debt implies a higher beta.

The CAPM is a forward-looking model which can be expressed as:

$$R_i = R_f + b_i \left[R_m - R_f \right]$$

where

R_i is the expected return on asset i

R_f is the risk free rate

R_m is the expected return on the market portfolio

$$b_i = \frac{\operatorname{cov}(R_i, R_m)}{s_m} = \text{ Systematic risk of asset } i$$

For practical application, CAPM requires estimates of the risk-free rate, the expected return on the market portfolio and the beta measure. The cost of capital generated by the application of the CAPM will be in nominal post-tax terms. Complications therefore arise from the need to recognise tax payments and imputation credits. The estimation of QR's below rail coal network in the CAPM/WACC framework therefore requires the estimation of the following parameters:

- the risk-free rate;

- the market risk premium;

- the proportion of debt funding and capital structure;

- the cost of debt;

- asset and equity betas;

- dividend imputation; and
- tax rates.

Finally, there is an issue as to whether the WACC will be presented in real or nominal terms.

Conflicting views often exist as to what represents the most appropriate method for the measurement of each of these parameters. This section provides an outline of issues to be considered in the estimation of each of the parameters.

4.1 The risk-free rate

The derivation of a return on equity under CAPM requires the estimation of a risk-free rate. The risk-free rate represents the rate of return on an asset with zero default risk. In quantifying the risk-free rate, it is important to note that the rate of return provides compensation for a network owner's past investment and an indication of the rate at which future investment will be compensated. It is in this context that the risk-free rate needs to be considered. There are two issues that need to be assessed in the choice of an appropriate proxy for the risk-free rate:

- what maturity period of bonds should be used to identify the interest rate; and
- the method of measurement of the risk-free rate.

The choice of an appropriate maturity

Typically, this debate centres on whether the maturity of the risk-free rate should be set equal to, or as close as possible to, the life of the asset or to the regulatory review period. The following approaches can be used as proxies for the appropriate maturity of the risk-free rate:

- the 10-year Commonwealth Government spot market bond;
- the use of spot or combined spot and forward rates corresponding to regulatory review periods; and
- QR's proposed approach of using a forward rate which has the impact of extending the maturity of current spot market risk-free assets.

10-year Commonwealth Government spot bond market - for consistency with the CAPM framework, Officer[9] states "the appropriate rate is that on a risk-free security, for example a Government bond or note, of the same duration as the term of the investment."[10]

The 10-year Commonwealth Government spot bond yield is a commonly used proxy for the risk-free rate as it is a liquid instrument, provides the best reflection of the market risk-free rate and can be identified using available market data. In Australia it is conventional to use the redemption yield of 10-year Commonwealth Government bonds as a proxy for the risk-free rate.[11]

[9] Officer, R.R. (1981), 'The Measurement of an Entity's Cost of Capital', *Accounting and Finance*, vol 21(2), p. 43.

[10] This view is supported in Lally, M. (2000), 'The Cost of Equity Capital and its Estimation', vol. 3, McGraw Hill Series in Advanced Finance, McGraw Hill, Sydney, p. 18, who states that "If the cost of equity capital is being used for setting an allowable rate of return over time interval T, we assume the CAPM relates to interval T and the risk-free rate is then the spot rate for interval T." Lally notes however that not all government securities at different horizons are actively traded.

[11] The 10-year Commonwealth bond rate is supported in recent private correspondence (25 July 2000) from Professor Bob Officer to the QCA. Officer noted that "In Australia, it has been conventional to use a 10-year Government bond yield as a surrogate for the *risk-free rate of return*."

The link between the longevity of the regulated assets and the planning/investment decision horizon of investors needs to considered in determining the life of the risk-free asset. As noted by the ORG:[12]

> "In other relevant jurisdictions, there is recognition that amortisation of relevant assets must be over their full economic life which implies that investors must have an expectation that they will be compensated for making long term investments before they commit to the investment. Therefore, even though regulators may review investment returns at regular intervals, it would be a mistake to believe investors' planning horizons only extend to the next review. Models of expected returns and any regulation of those returns must reflect and take account of the investors' planning horizons. The reapplication of the prevailing long term rate every five years is sufficient to achieve this, as the owners of the project make their investment decision based on the life of the project, using the appropriate discount rate determined with reference to the prevailing yield curve."

It is also important to ensure that there is consistency between the choice of risk-free rate and the assumed market risk premium. As noted by ORG,[13] given that the available risk premium is expressed relative to the 10-year bond rate, this rate is preferred as there is no additional benefit for calculation of the equity rate of return in using the 5-year bond rate. The ORG demonstrated that selection of the 5-year bond rate as the risk-free rate would require the application of a market risk premium which measures the expected return on equities as a margin over the 5-year bond yields:[14]

> "It has been suggested for example, that the choice of a shorter (or longer) rate will just lead to a higher (or lower) measured market risk premium, with no effect on the expected return for the well-diversified portfolio (and hence little effect on the required equity return). As the estimation of the market risk premium generally has used the current yield to maturity on Commonwealth Government securities of about ten years until maturity, this argument suggests that the risk-free rate should reflect a security of a similar term." [15]

The ORG[16] also noted that some gas industry stakeholders had expressed concern that the use of short term rates will cause companies to concentrate their re-funding around each price review determination. It was argued by gas industry stakeholders in Victoria that the use of short term rates would cause periodic spikes in corporate bond rates due to the concentration of re-financing around the time of each re-set of the regulatory WACC.

The use of rates corresponding to regulatory review periods - it has been argued that if the allowable WACC is revised at set intervals, the risk-free rate should be set with reference to the regulatory period. The primary arguments[17] for using a rate linked to the regulatory review period initially arose from criticisms directed at the proposed use of the longer 30-year rate in the Victorian Gas draft decision as opposed to a debate between the regulatory period versus the 10-year rate.

[12] See Office of the Regulator-General, Victoria, 'Weighted Average Cost of Capital for Revenue Determination: Gas Distribution', Staff Paper Number 1, May 1998, p. 14.

[13] Office of the Regulator-General, Victoria, 'Weighted Average Cost of Capital for Revenue determination: Gas Distribution', Staff Paper No. 1, 28 May 1998.

[14] This suggests that if the 5-year bond rate is selected as the risk-free rate, a 20 to 40-point margin should be subtracted from any market risk premium measured with reference to the 10 year bond rate. In these circumstances, the 5 year rate would be lower, but the market risk premium would be consistently higher. Given that the spread between 5 and 10-year bonds is typically under 40 points, these differences would cancel each other out.

[15] Office of the Regulator-General, '2001 Electricity Distribution Price Review: Cost of Capital Financing', Consultation Paper No. 4, May 1999, p. 46.

[16] Office of the Regulator-General, Victoria, Access arrangements for Multinet, Westar and Straus, October 1998, pp. 195-196.

[17] ACCC and ORG, Public Forum on the weighted average cost of capital in the Victorian Gas Access Arrangements, 3 June 1998.

Davis[18] suggests that if the allowable WACC is to be revised periodically, then it is not necessary to use a long term rate for the risk-free rate. Rather, Davis seeks to relate the prevailing interest rate to the length of the review period:

> "Given the anticipated life of the assets and the likely time pattern of the resulting cash flows, it would seem very difficult to sustain an argument for use of a risk-free rate greater than 10 years. Use of a shorter maturity rate would not be inappropriate – particularly if there were to be regular regulatory pricing reviews."

Davis[19] also recommends that the appropriate maturity to be utilised in determining a discount rate is a 1-period discount rate to value 1-period cash flows and their terminal value. To facilitate this approach, Davis recommends the "valuation of all future cash flows using relevant spot rates, where the future cash flows are estimated using implied forward rates."[20] Davis acknowledges though that in performing a valuation at date 0, both the future cash flows and the future spot rates are unknown. However, he argues that the forward rate can be implied from the current spot curve. Notwithstanding this, use of the forward market is inappropriate as it is inconsistent with the underlying assumptions of the CAPM.

Other arguments used to support the use of a rate linked to the regulatory period include that:

- rarely does initial debt funding for capital investments extend beyond 10 to 15 years and in any event, as noted by the Commonwealth Bank of Australia, it is likely that interest swaps would be re-set on a five yearly basis.[21] The Authority notes though that interest rate swaps are available for a range of maturities from 1 to 10 years; and

- even where a long term cost of capital is appropriate to the valuation of long-lived assets, it does not follow that it is appropriate for pricing decisions in the short run when the asset values are annually adjusted for inflation (thus removing a need for an inflation risk premium) and the allowable cost of capital can be revised at each review (to adjust for long term changes in market perceptions).

Another argument supporting the use of short term rates suggests that the interest rate risk associated with holding interest securities increases with the time to the maturity date and that this is priced into the security[22] and increasingly so for longer term substitutes. In this case it is argued that the appropriate term for calculating the risk-free interest rate for CAPM should therefore be shorter term bond rates as these instruments have less risk than long-term instruments. Empirically, yields on risk-free securities at the short end of the yield curve are lower and more volatile than longer dated yields that will result in volatile market risk premium estimates. Thus access charges based on short term interest rates will tend to be lower than those based on long term yields but will experience greater volatility.

[18] Davis, K. 'Analysis of the Cost of capital for necessary new investment at Perth International Airport: Submission to the ACCC Western Airports Corporation', January 1999.
[19] Davis, K. (1999), 'Asset Valuation, Cost of Capital, and Access Pricing in the Australian Gas Industry', Research paper 99-02, Dept. of Accounting and Finance, The University of Melbourne, p. 15.
[20] Implied forward rates are derived from the current spot rate curve. But the calculation of a forward rate is conditional upon the availability of a spot rate corresponding to the different maturities m and n (where $m > n$). Spot rates are equivalent to the yields to maturity on zero coupon bonds of the same maturity. If market traded spot rate yields are unavailable the spot rates can be calculated using an filtering method from existing coupon bonds. To imply a spot rate beyond the last available market traded coupon bond would require an extrapolation of the yield curve using any one of a number of curve fitting methods or alternatively assuming the coupon and yield for a longer dated bond and including it in any calculations.
[21] Commonwealth Bank submissions to ORG - 3 March 1998, p. 2; 19 June 1998, p. 3.
[22] Brealey, R. and Myers, S., *Principles of Corporate Finance*, Sixth Edition, 1999, McGraw-Hill; Hetheringtonne, B., Estimating the Rate of Return for Gas Transportation, 1992, The Office of Gas Supply; Macquarie Risk Advisory Services Limited, Weighted Average Cost of Capital for Victorian Gas Distribution Access Arrangements, July 1998.

QR's submission - QR has argued that it is more appropriate to use a 'forward' yield on the 10-year bond rate which is consistent with the period expected between price reviews undertaken by the regulator. It justifies the use of the forward rate by arguing that "QR's Access Undertaking contemplates a period of 3 years between reviews of its reference tariffs and an evaluation period of up to 10 years". QR's consultant[23] argues that the rationale for the use of a forward as opposed to a spot rate is that it allows a WACC to be estimated using a 'bond' at the mid-point of a revenue cap period[24] and will consequently reduce the price spikes observed in spot prices.

QR's submission proposes a 3-year forward on the Commonwealth Government bond 10-year rate (${}_nf_m = {}_3f_{13}$) as a proxy for the risk-free rate in calculating Network Access' Cost of Capital. The net effect of this would be to artificially generate a risk-free rate that has a maturity 13 years from the date of commencement. The following information is taken from page 23 of QR's submission:[25]

Table 3: QR's risk-free rate proxy data

Basis	Value at 30/6/99	20-day average
10-year spot	6.27	6.23
3-year spot	5.72	5.74
3-year forward	6.51	6.44

QR argues that the forward rate better captures the risk inherent in applying a static rate of return target for the period between reviews, particularly where there is a definite bias towards an increase in interest rates. QR believes that its rail infrastructure asset values would be adversely affected if it were unable to pass this increased opportunity cost on in its access charges due to the reference tariff being capped by the revenue limit.

In QR's submission, data is provided for the 3-year and 10-year spot rates and a forward rate is calculated. However, QR's submission does not identify the required 13-year spot rate which is needed to calculate the 3-year forward 10-year rate of 6.51 %. Instead, QR indicates that these rates have been sourced from the Queensland Treasury Corporation. Hence direct validation of the calculated forward rate is not possible from the available data. In the Australian market, the longest available Commonwealth Government Treasury bond at 30 June 1999 was the 5.75% coupon bond maturing at June 2011. This bond matured approximately 12 years from 30 June 1999.[26]

[23] Green, Edwell Consulting Pty Ltd – letter to Network Access QR dated 23 May 2000.
[24] The regulatory review period will initially be 3 years – which implies a rate of 18 months rather than 3 years is required to achieve the mid-point.
[25] The table has a footnote stating that "All rates are sourced from Queensland Treasury Corporation and are in nominal terms."
[26] At 30 September 2000, this bond was still the longest maturity non capital indexed bond on issue by the Commonwealth Treasury.

Analysis of alternative approaches - the QCA has concerns as to the efficacy of QR's proposed approach as it relies on one particular market participant's expectation of a longer term rate (which in turn is a derivative of the 10-year bond rate). Consequently, it is not a market-determined rate. If such an approach were justified, then it would not make sense to limit the life of the derived security to a future 10-year security as it would be more appropriate to adopt a horizon corresponding to QR's average asset life. Indeed, the use of a forward rate is inconsistent with CAPM.[27]

Moreover, the QCA does not accept the argument that the forward rate better captures the risk inherent in applying a static rate between reviews, particularly where there is a definite bias towards an increase in rates. First, QR itself is proposing a static rate be applied – it is just a different term (being a 13-year rate) to that observed in the market (which is a 10-year rate). QR does not explain why current rates would not reflect market expectations of a rise in long term rates.

Finally, it is not clear why QR's approach would reduce price spikes observed in spot prices. As the forward rate proposed is not traded, it is not possible to assess the likelihood of QR's proposed approach avoiding price spikes.

The next issue concerns whether the risk-free rate of return should be measured against the 10-year Government bond or a bond corresponding to the length of the regulatory period. The regulatory period proposed under QR's Draft Undertaking is 3 years. The Authority therefore examined the time series properties of 3 and 10-year Commonwealth Government bond rates from June 1992 to June 2000.

As shown in Figure 1, the observed patterns in these interest rates appear to be primarily driven by shifts in monetary policy.[28] It noted that both the 3 and 10-year Commonwealth bonds have traded at a range from over 10% to under 5% in the space of the last 8 years, even though they have traded below 10% since February 1995 – a period of low inflation. The regime shift to the lower inflation period is typical of evidence usually found to support non-stationarity.

The Authority notes that visually the spread between the 3 and 10-year rates is quite narrow. However, Table 4 illustrates that the average yield on 3 and 10-year Commonwealth Government bonds over various periods, based on monthly averages and the spread between the rates, has varied over time and been substantially different at various times. Also, for almost all of the period, the 3-year rate has been systematically lower than the 10-year bond rate.

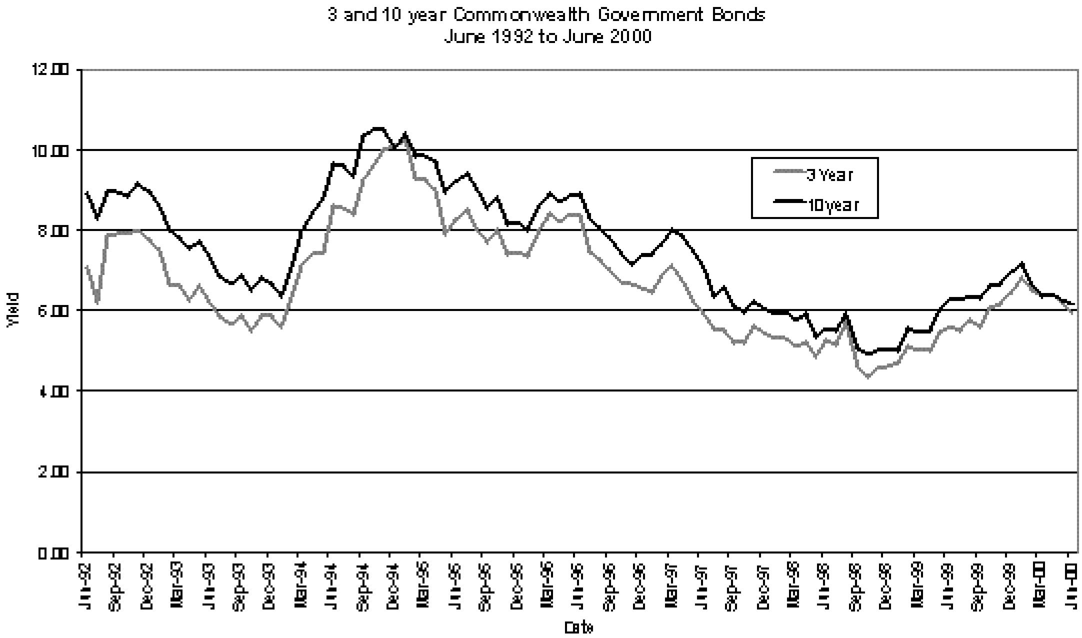
[27] Forward rates are derived from the spot yield curve rather than the coupon yield curve and are not market determined rates. The rates derived reflect the interpolation and filtering methods used to derive the spot yield curve and to calculate the forward rates. Therefore QR's approach implicitly assumes that forward rates are unbiased estimates of future spot rates.

[28] As noted in Pagan, A.R., A.D. Hall & V. Martin, 'Modelling the Term Structure', ANU Working Papers in Economics and Econometrics, No 284, June 1995, evidence of non-stationary behaviour would imply the possibility of negative interest rates as interest rates would be slow to revert to their long term average levels. Hence decreasing interest rates could become negative. Non-stationarity of interest rates would also have the impact of restricting the ability to forecast future spot rates.

Table 4: Average 3 and 10-year Commonwealth Government bond yields

Time period	3-year Commonwealth bond yields (%)	10-year Commonwealth bond yields (%)	Difference between 10 and 3-year Commonwealth Bond yields (%)
1999	5.55	6.08	0.53
1998 –1999	5.28	5.79	0.51
1995 –1999	6.50	7.16	0.66
1992 – 1999	6.77	8.52	0.79
As at:			
31 December 1999	6.47	6.96	0.49
31 March 2000	6.38	6.36	-0.02
30 June 2000	5.97	6.16	0.19

Figure 1



The 10-year bond rate is a signal for long term investment – it represents the expected return from holding a risk-free security for the next 10 years. If the incorrect rate is applied, by using an inappropriate maturity, then this will cause resource allocation distortions. For example, if too low a risk-free rate is set, QR would not be adequately compensated for its investment. Whilst this would lower prices in the short term, QR would be unlikely to undertake further investment in the network, leading to congestion and an inability of shippers to deliver their product to their market in the longer term.

The rate of return allowed as part of a regulatory decision is not only important to provide a return on past investment. It also provides a signal for long term decision making. Accordingly, the use of shorter term securities as benchmarks for decisions affecting long term assets could distort these investment decisions.

Further, the review period for an investment is not relevant to return expected from holding an asset over its life. To highlight that it is inappropriate to use shorter dated securities as the proxy for the risk-free rate consider the following example. Assume an investor held a bond portfolio with an expected life of 10 years and monitors the portfolio daily. The benchmark applied would be the 10-year bond rate as opposed to the official overnight cash rate.[29] To apply the daily rate would be inconsistent with the life of the asset and the risk in the equity risk premium.

The use of a long maturity for the risk-free rate is also supported by the finding in the empirical literature that there is no base level to which both short and long term nominal interest rates in Australia and international markets systematically return.[30] In other words, interest rates exhibit non-stationarity.[31]

Table 5 summarises the approaches taken by regulators in other jurisdictions to the 10-year bond rate. It shows that all regulators, except the ACCC, have consistently used the 10-year rate as the proxy. In the case of the ACCC, results are mixed with a preference for a rate linked to the regulatory review period.

[29] Comments by Dr Neville Hathaway at ACCC and ORG, 'Public Forum on the Weighted Average Cost of Capital (WACC) in the Victorian Gas Access Arrangements', 3 June 1998, p. 82.

[30] Australian examples of the empirical evidence include Ann, A.T.H. & L. Alles (1999) 'An Examination of the Causality and Predictability between Australian Domestic and Offshore Interest Rates', Working Paper No. 99-09, Department of Economics and Finance, Curtin University (examined bank accepted bills and AUD-Euro deposits); Mishkin, F.S. & J. Simon (1995), 'An Empirical Examination of the Fisher Effect in Australia', *The Economic Record,* vol. 71(214), pp. 217-229 (examined treasury notes); Moschos, D.M. (1995), 'The Information Content of the Yield Curve in Australia' *Journal of Macroeconomics*, vol 17(1), pp. 93-109 (examined cash rates, Treasury notes and 2,5 and 10-year bonds).

[31] Typical visual characteristics of non-stationarity include that the series either grows in a secular way over long periods of time (such as time series representing aggregate economic behaviour such as GDP), or the series gives the appearance of wandering around as if it has no fixed population mean (typically found in asset prices such as share prices). Alternatively, a time series may give the appearance of non-stationarity due to structural changes in the underlying economy which cause sharp and sudden shifts in mean levels.

Table 5: Risk-free rate

Regulatory Decision	Industry	Benchmark Commonwealth bond
ACCC:		
Epic Energy [32]	Gas distribution	5-year nominal
Central West Pipelines [33]	Gas distribution	10-year nominal
Snowy Mountains Hydro Transmission network[34]	Electricity transmission	5-year nominal
NSW & ACT Transmission networks[35]	Electricity transmission	10-year nominal
IPART:		
AGL Gas Networks[36]	Gas distribution	10-year nominal
NSW Electricity Distribution networks[37]	Electricity distribution	10-year nominal
Albury Gas Company [38]	Gas distribution	10-year nominal
Electricity Networks & Retail Supply[39]	El. Distribution/ retail	10-year nominal
NSW Rail[40]	Rail	10-year nominal
Great Southern Energy [41]	Gas distribution	10-year nominal
OffGAR:		
Parmelia Pipeline [42]	Gas transmission	10-year nominal
Tubridgi Pipeline [43]	Gas transmission	10-year nominal
Mid-west and South-West Pipeline[44]	Gas transmission	10-year nominal
ORG:		
Victorian electricity distribution[45]	Electricity distribution	10-year inflation indexed
Victorian ports[46]	Ports	10-year inflation indexed
Victorian gas distribution[47]	Gas distribution	10-year nominal
SAIPAR:		
South Australian gas distribution[48]	Gas distribution	10-year nominal

[32] Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

[33] Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

[34] Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

[35] Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

[36] Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

[37] Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

[38] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

[39] Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

[40] Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

[41] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

[42] Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

[43] Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

[44] Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

[45] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

[46] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

[47] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

[48] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

It would appear that the debate between the use of the 10-year bond rate or the regulatory review period has been confused by two unrelated issues:

- the original debate involved discussion between the alternatives of either using a 30-year bond rate versus one with a term equivalent to the regulatory review period; and

- the debate occurred at a time when there was no material difference due to the flatness of the yield curve between 5 and 10-year real bond rates. Since the yield curve has returned to the usual ascending yield curve, this argument is no longer relevant.

After considering each of the above alternatives, the Authority supports the view that the bond rate used for modelling purposes should most closely approximate the lives of the assets of the business being regulated. However, in the Australian market, bonds beyond 10 years are not particularly liquid. In Australia it is conventional to use the redemption yield of 10-year Commonwealth Government bonds as a proxy for the risk-free rate, because it is a liquid instrument, provides the best reflection of the market risk-free rate and can be identified using available market data.[49]

Measurement of the risk-free rate

Having accepted that the 10-year Commonwealth bond is the appropriate instrument and maturity to use as a proxy for the risk-free rate, the next issue for consideration is the appropriate method of measurement. Two alternatives are available:

- the use of the 'on-the-day' current market yield of the spot 10-year Commonwealth Government bond rate; or

- the use of an average historical spot 10-year Commonwealth Government bond rate.

Use of the on-the-day current market yield - it is theoretically correct to use the current risk-free rate in CAPM models. This is because in an efficient market, asset prices (including bond yields) reflect all available information including any historical information about previous prices (yesterday, last week, last month etc). Hence the current yield on a bond should reflect expectations from all relevant assessments.[50] In other words, the 10-year bond rate at a point in time already incorporates all the historical information that would be inferred from an historical average. On this basis, an averaging process would actually introduce an unwarranted bias into the assessment of the risk-free rate.

It is possible that use of this current rate will introduce a degree of short term volatility into the interest rate measure. This variability may be induced by central bank intervention in changing cash rates on the day of the determination, day of the week effects in the data, or other sources of variability linked to trading activity. However, price theory suggests that any such effects can be readily identified by market participants and, in a deeply traded market such as the 10-year Commonwealth Government bond market, could reasonably be expected to be traded away through participants establishing appropriate arbitrage strategies.

The current on-the-day risk-free rate can be estimated in either nominal or real terms.[51] As the WACC is to be estimated in nominal terms, the nominal yield on 10-year bonds will be applied.

[49] This view was supported in private correspondence (25 July 2000) from Professor Bob Officer to the QCA.
[50] Including fundamentalist, technical analyst and quantitative assessments.
[51] The nominal rate of return is a function of both the real rate of return and inflation. Recent academic literature suggests that inflation can be decomposed into both expected inflation and an inflation risk premium to reflect the difference between realised and expected inflation. Hence inflation implied from the relationship between nominal and real bonds is overstated.

Use of average historical spot rates - as an alternative to the current spot rate, it has been suggested by some regulators that the use of an historical average or other filter based on recent historical data will smooth out current spot market variability.[52] This approach can result in distortions to the level of the risk-free rate due to the smoothness and the mistiming of turning points induced by longer averaging periods. Averaging has the impact of introducing a lagged effect in the level of the risk-free rate relative to its current level. This distortion induced by the lagged effect is exacerbated as the averaging period increases. As shown in Table 6, regulatory agencies have typically applied an average of the long term rate in their determination of the risk-free rate.

Table 6: Risk-free rate estimation methods applied by Australian regulators

Regulatory Decision	Industry	Estimation factor
ACCC:		
Epic Energy[53]	Gas distribution	40-day average
Central West Pipelines[54]	Gas distribution	40-day average
Snowy Mountains Hydro Transmission network[55]	Electricity transmission	40-day average
NSW & ACT Transmission networks[56]	Electricity transmission	40-day average
IPART:		
AGL Gas Networks[57]	Gas distribution	20-day average
NSW Electricity Distribution networks[58]	Electricity distribution	20-day average
Albury Gas Company[59]	Gas distribution	20-day average
Electricity Networks & Retail Supply[60]	Electricity distribution/ retail	20-day average
NSW Rail[61]	Rail	20-day average
Great Southern Energy[62]	Gas distribution	20-day average
OffGAR:		
Parmelia Pipeline[63]	Gas transmission	20-day average
Tubridgi Pipeline[64]	Gas transmission	20-day average
Mid-west and South-West Pipeline[65]	Gas transmission	20-day average

Empirical evidence from the UK suggests that the inflation risk premium is also time varying causing problems in its quantification.

52 The longer the moving average, the smoother the series generated.

53 Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

54 Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

55 Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

56 Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

57 Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

58 Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

59 Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

60 Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

61 Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

62 Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

63 Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

64 Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

65 Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

Regulatory Decision	Industry	Estimation factor
ORG:		
Victorian electricity distribution[66]	Electricity distribution	20-day average
Victorian ports[67]	Ports	20-day average
Victorian gas distribution[68]	Gas distribution	2-month average
SAIPAR:		
South Australian gas distribution[69]	Gas distribution	n.a.

The QCA undertook an analysis of the 10-year Commonwealth Government bond rate relative to 5, 10, 20 and 40-day moving averages.[70] The results are reported in Appendix B. The Authority found that moving average data is incorporated within the range of the spot market data and that the use of the moving average measures results in a lag following turning points in the spot market series. This is due to the averaging process with the 40-day rate slower to react than the other averages. Consequently the Authority concluded that the use of moving averages added no further information to the identification process.

Figure 2 shows daily 10-year Commonwealth bond yields during the period from January 1996 to June 2000. During this period, 90% of all absolute rate changes are less than 12 basis points, 95% less than 15 basis points and 99% less than 22 basis points. The 10-year interest rate moved by greater than 22 basis points on ten occasions during the sample period – changes in RBA official rates accounted for 8 of these changes whereas 2 changes were due to market movements attributable to expected but unrealised interest rate changes.[71]

[66] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

[67] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

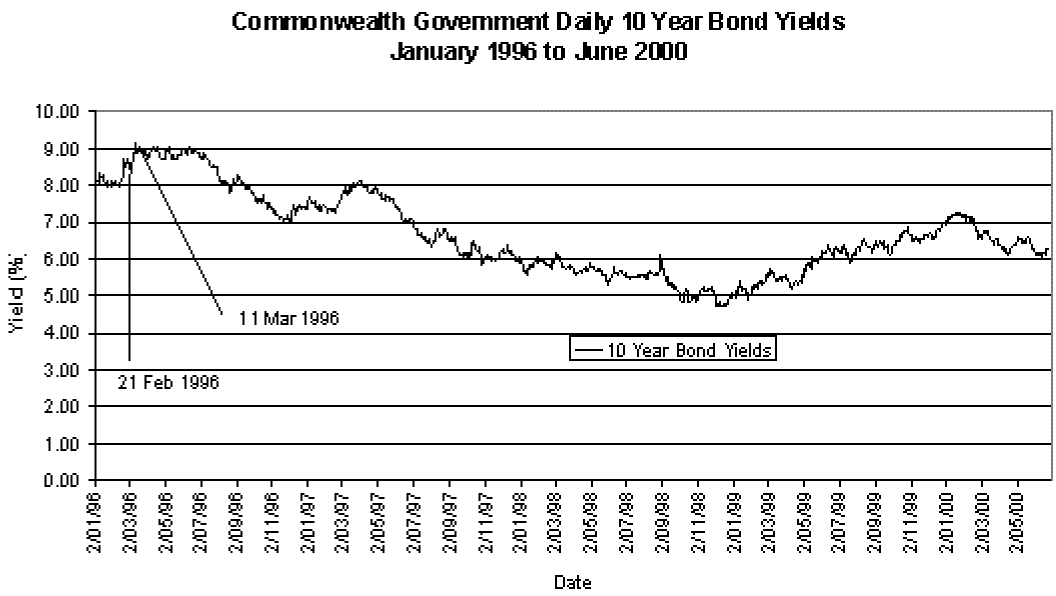
[68] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

[69] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

[70] The QCA also investigated several alternative smoothing methods including a centred 20-day moving average, a simple exponential smoothing filter (EXP), the Holt Winter – no seasonal filter (HW), and the Hoderick and Prescott filter (HP). However, each of the above models has serious limitations for use in the identification of an appropriate risk-free rate. For example, the centred MA (20) assumes perfect foresight of the next 10 observations to identify the current value and the EXP, HW and HP parameters are fitted using a least squares algorithm and therefore coefficients are sensitive to the inputted data. When considered relative to the 20-day MA, the Centred MA (20), EXP, HW and HP offer very little in additional efficiency in forecasting actual bond rates. The 20 and 40-day MAs offer more transparency in their calculation than these alternatives as this approach is easily understood by interested parties.

[71] On 21 February 1996, the 10-year rate rose 42 basis points and fell 18 basis points on the following day when official interest rates did not rise as expected. On 11 March 1996 the 10-year rate rose 48 basis points and fell 26 basis points on the following day when rate changes were again unrealised.

Figure 2



Changes in the level of interest rates due to unrealised expected news on interest rates should be regarded as extreme moves in interest rates and would therefore misrepresent the level of interests rates if applied in WACC calculations.

Based on the preceding analysis, the QCA has decided to use the 10-year Commonwealth Government bond rate measured at the time of deciding the rate of return for this draft report. This rate will be applied unless the rate is considered not to encompass all relevant information, such as where there is a perturbation in the market on the day in question.

A perturbation may be due to an extraordinary event occurring or by market expectations of an official rate change not being realised. The Authority considers that to depart from the rate of the day, any perturbation in the market that occurs on the day should be material in the context of historical movements. Accordingly, it is proposed that for a departure to occur, there be a movement on the day, followed by a movement of similar magnitude on the following day in the opposite direction, that together sum to in excess of 30 basis points.

If such a test is satisfied (which would have been the case on 2 trading days in the last 4 years[72]) then the Authority proposes to apply an average over the preceding 5 trading days. Given that regulatory decisions will generally not coincide with the release of new economic information to the market, such an adjustment is highly unlikely.

On 20 November 2000, the 10-year Commonwealth Government bond rate was 5.92% and the 5-day average was 5.96%. The 10-year Commonwealth Government bond rate rose from 5.87% to 5.92% (5 basis points) on 20 November 2000 and fell by 3 basis points to 5.89% on the next trading day. This represents a net absolute movement of 8 basis points over the 2 trading days. This rate change does not constitute an extraordinary event nor unrealised expectations and therefore supports the use of the on-the-day spot market figure. On this basis, the QCA would set the nominal risk-free rate of return at 5.92%. The risk-free rate will be updated prior to the release of the Final Decision. It is proposed that stakeholders will be advised of the date in advance.

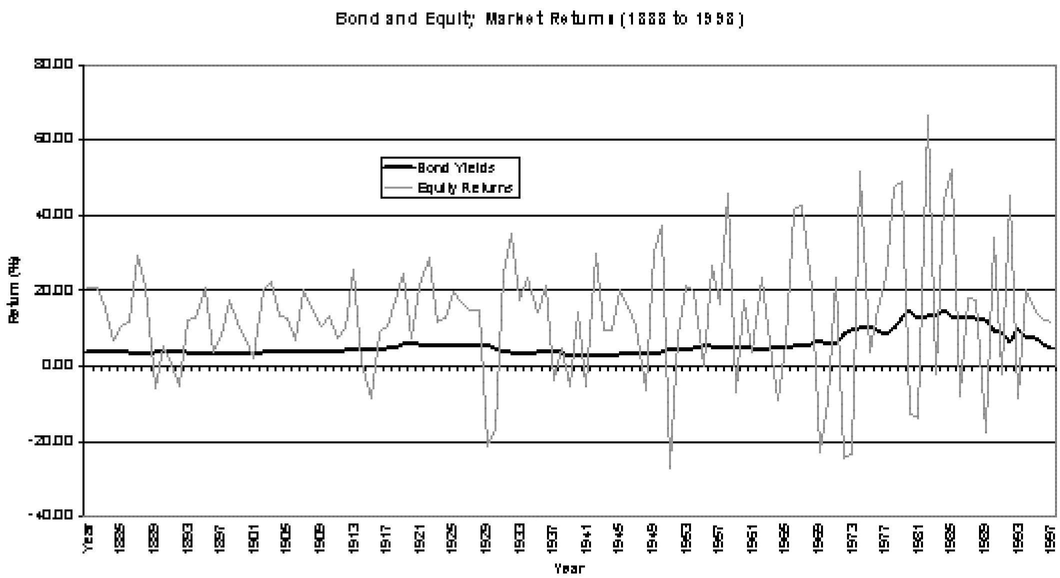
[72] During the 4-year period 1996 to 1999, 95% of daily absolute rate changes are less than 15 basis points. Thus a net change of greater than 30 basis points over two days would represent 2 consecutive days with rate changes greater than the 95th percentile of 15 basis points. Such rate changes would be regarded as outliers.

4.2 The market risk premium

An important input to cost of capital calculations involves the use of the CAPM formula to assess the return on equity. The equity risk premium represents the reward that investors require to accept the uncertain outcomes associated with owning equity securities.[73] It is measured as the extra return that equity investors expect to achieve over the risk-free rate.

The market risk premium is based on the difference between the return on the market as a whole and the risk-free rate, both of which vary over time. As shown below in Figure 3, equity market returns are significantly more volatile than debt market returns. Both the equity and debt markets are influenced by short term business cycles and the fact that measures of risk premia are influenced by the measurement period.

Figure 3



In theory, the CAPM requires that a forward-looking market risk premium be based on a time-frame corresponding to the period of the analysis (that is, the life of the asset). However, in practice this data does not exist. Alternative methods to estimate the market risk premium include the following:

- surveys;
- the calculation of an implied risk premium based on a discounted dividend growth model or based on accounting data[74];
- consumption based modelling; and
- historical data.

[73] As investors become more risk averse, they should demand a larger premium for shifting from the risk-free asset and as the riskiness of the average risky investment increases, so should the premium to compensate investors for the increased risk.

[74] An alternative theoretical approach to generate a forward-looking share price index would be to match the index level stated in Share Price Index (SPI) futures contracts with a maturity of 10 years with the current 10-year bond rate. However, SPI futures only have a maximum maturity of six quarters ahead and thus this method is not practical. One could imply a 10-year forward SPI futures price using an implied futures price but this would not reflect a traded price and would be conditional on the level of expected dividends.

Survey-based methods

Surveys of portfolio managers are conducted to assess expectations of the future risk premium. However, they suffer the following limitations:

- no constraints on reasonability;
- volatility induced by recent events; and
- the tendency for the surveys to reflect short term expectations.

Calculation of an implied risk premium based on a discounted Dividend Growth Model or on accounting data

The implied risk premium as discussed in Damodaran[75] is derived from a dividend discount formula, first advocated by Gordon.[76] In this forward-looking model, dividends are assumed to grow at a constant rate in perpetuity:

$$P = \frac{E(D)}{\left(R_e - E(g)\right)}$$

where

E(D) = the Expected Dividends in the next period

R_e = the Required return on Equity

E(g) = the expected growth rate

rearranged

$$R_e = \frac{\left[E(D) + P \times E(g)\right]}{P}$$

Once the return on equity is calculated, the market risk premium is calculated by subtracting the risk-free rate. Typically this method has resulted in lower estimates of the market risk premium than historical methods. This approach suffers from the limitations that:

- it requires expected measures of earnings and dividend growth rates which are not directly observable. Such information is subjective and opinions can vary among market participants;[77] and
- in practice dividends are not paid at a constant rate in perpetuity.

[75] Damodaran A. (1999), *Applied Corporate Finance: A User's Manual*, John Wiley and Sons, New York.

[76] M. Gordon (1962), *The Investment, Financing and Valuation of the Corporation*, Richard D.Irwin, Homewood, Illinois.

[77] For example, assume the All Ordinaries Index is at 3000, the expected dividend yield on the index is 2.5%, and the expected growth rate in earnings and dividends in the long term is 7.5%. The required return on equity (R_e) is:

$$3000 = \frac{(0.025 * 3000)}{(R_e - 0.075)}$$

$$R_e = \frac{\left[(0.025*3000) + (0.075*3000)\right]}{3000} = 0.10$$

Assuming an expected return on the risk-free asset of 6.5%, the implied market risk premium is 0.10 – 0.065 = 0.035, or 3.5%.

Attempts have also been made to infer the market risk premium from the analysis of accounting variables, such as accounting based earnings. The validity of this method is conditional on 3 primary assumptions:

- that earnings are the primary driver of equity market returns;
- that past earnings are directly related to future earnings; and
- that the relationship could be represented in a linear framework.[78]

Consumption Based Modelling

Cochrane[79] noted that the equity risk premium can be expressed theoretically as a function of the covariance between changes in consumption and the level of the risk-free rate.[80] Cochrane justifies the use of consumption-based models to explain the market risk premium on the premise that consumption involves a decision about current versus deferred consumption which is conditional on the risk preferences of the individual.

From a theoretical perspective, it has been suggested that the market risk premium is too high to be consistent with reasonable estimates of risk aversion.[81] The anomaly of the results from consumption based models was first identified and called the equity premium puzzle by Mehra and Prescott.[82] They found that an exchange economy equilibrium model could not reproduce the secular difference observed between the average rate of return on equity and the average rate of return on short term risk-free debt for reasonable configurations of preferences and endowment.

However, consumption-based models are usually found to offer little explanatory power. Also, several arguments have been used to suggest that the results obtained through consumption based models have been misleading and that alternative explanations exist for the existence of the equity premium puzzle. For example:

- Brown, Goetzmann and Ross[83] argue that because the economy and stock market have performed so well over a long period of time, this results in an upward bias in average returns. This phenomena has come to be known as a survivorship bias;

[78] See O'Hanlon J. and A. Steele (1997), 'Estimating the Equity Risk premium Using Accounting Fundamentals', Working Paper, Department of Accounting and Finance, Lancaster University, and Claus, J.J. and J.K. Thomas (1999), 'The Equity Risk Premium is Lower than You Think it is: Empirical Estimates from a New Approach', Working Paper, Columbia University.

[79] Cochrane, J.H. (1997), 'Where is the Market Going? Uncertain Facts and Novel Theories', *Economic Perspectives*, Federal Reserve Bank of Chicago, vol. 21(6).

[80] The relationship is expressed mathematically as follows:

$$E(r) - r^f = f\,\mathrm{cov}(\Delta c, r) = f s(\Delta C) s(r) corr(\Delta c, r)$$

where

$E(r)$ is the expected return on the asset

r^f is the risk free rate of return

ΔC is the proportional change in consumption

f is the measure of risk aversion

[81] Jenkinson (1998), 'The Equity Risk Premium: Another Look at History', *Utilities Journal*, argues that the observed high equity premium in the past has been due to very poor returns on bonds, which would not be expected to continue in the future due to more liberal financial market.

[82] Mehra, R. and E.C. Prescott (1985), 'The Equity Premium: A Puzzle', *Journal of Monetary Economics*, vol. 15, pp. 145-161.

[83] Brown, S., W. Goetzmann and S. Ross (1995), 'Survival', *Journal of Finance*, vol. 50, pp. 853-873.

- Rietz[84] suggests that investors' risk preferences are such that when setting market prices investors take account of a small positive probability of an important catastrophic event occurring. If the event does not occur within the sample period, investors may appear to be irrational. This is known as the 'peso problem'; and

- Quiggin[85] noted that although the equity premium remains a puzzle, the most promising explanations rest on a combination of two violations of the perfect capital market assumption. The premium demanded by investors for holding equity with associated systematic risk is explained by the fact that, because of adverse selection problems, individuals cannot insure themselves against recessions. Meanwhile, the fact that the borrowing rate facing individuals is substantially higher than the bond rate invalidates the suggestion that 'home-made' consumption smoothing will eliminate the excess risk premium.

Historical data

Officer[86] measured the market risk premium as the difference between the arithmetic nominal return to shares and the average annual yield on long-dated government securities.[87] During the period 1882 to 1987, Officer found the market risk premium to be at the average level of 7.94%. Numerous studies have used Officer's approach to estimating the market risk premium. The findings of Australian academic studies and regulatory decisions, reported in Tables 7 and 8, suggest that the market risk premium ranges from 6 to 8% with recent regulatory decisions favouring the lower range of 5 to 7%.[88] The most recent Australian studies show strong support for a market risk premium at 6.00%. Market risk premiums for the United Kingdom and the United States are also reported in Table 8.

There are numerous problems with the use of historical data to estimate the market risk premium including:

- the choice of proxies for the risk-free rate and the return on the equity market. Typically studies will use the All Ordinaries Accumulation index as their proxy for the equity market and the 10-year Commonwealth Government bond rate as proxy for the risk-free rate;

- the choice of an averaging period so as to obtain a representative level of the expected risk premium;

- the problem of structural breaks[89] which may cause the average ex-post returns for the market and the risk-free rate to differ materially from the expectation period;

- while market risk premium is commonly estimated based on historic evidence, there is considerable debate over the validity of this approach. It has also been suggested that the historical premia for successful equity markets such as the United States may be distorted by survivor bias;[90] and

[84] Rietz, T. (1988), 'The Equity Risk Premium: A Solution', *Journal of Monetary Economics*, vol. 21, pp. 117-132.
[85] Quiggin, J. (1997), 'The Equity Premium and the Government Cost of Capital: A Response to Neville Hathaway', *Agenda*, vol 4(4).
[86] Officer, R. (1985), 'Rates of Return to Shares, Bond Yields and Inflation Rates: An Historical Perspective', Chapter 14 in R. Brown, R. Ball, F. Finn and R. Officer (eds), *Share Markets and Portfolio Theory*, 2nd edition, UQ Press, Brisbane Australia.
[87] The averages were calculated using 10-year windows for data.
[88] This range is also supported in recent private correspondence (July 2000) from Professor Bob Officer to the QCA.
[89] A structural break occurs when time series data switches from one regime to another due to an exogenous shock. For example, the deregulation of Australian interest rates in 1979 or the floating of the Australian dollar in December 1983.
[90] Damodaran A., Estimating Equity Risk Premiums, Stern School of Business (http://www.stern.nyu.edu/~adamodar/).

- the problem of whether the averages should be arithmetic or geometric. Arithmetic means are consistent with the CAPM framework[91] as bonds are priced using discrete compounding of interest rates. However, the use of geometric means has been justified on the grounds that it takes into account continuous compounding. Geometric averages will be lower than arithmetic averages.

As noted above, the measurement of the equity risk premium is usually undertaken via the use of historical data proxying for both the market portfolio and for the risk-free rate. Although a market risk premium is stated in a number of reports and academic articles, not all of these studies are clear in detailing which data was used in their calculations. This may lead to measurement errors in any comparisons between market risk premiums over time – especially given that short term interest rates are typically more volatile over time than long term rates.

The quantification of the market risk premium

Due to the reasons outlined above, the Authority rejects the use of survey methods, methods based on the discounted dividend growth model and consumption-based models for estimating the market risk premium. Consistent with most Australian studies and regulatory decisions, the QCA proposes to estimate the market risk premium from historical data.

As stated earlier, Table 7 summarises the market risk premium that has been adopted in Australian regulatory decisions and Table 8 outlines the empirical evidence flowing from various other studies on the market risk premium in Australia and overseas.

[91] Bonds are priced using discrete compounding.

Table 7: Market risk premium

Regulatory Decision	Industry	Market risk premium (%)
ACCC:		
Epic Energy [92]	Gas distribution	6.00
Central West Pipelines [93]	Gas distribution	6.00
Snowy Mountains Hydro Transmission network[94]	Elec. transmission	6.00
NSW & ACT Transmission networks[95]	Elec. transmission	6.00
IPART:		
AGL Gas Networks[96]	Gas distribution	5.00 – 6.00
NSW Electricity Distribution networks[97]	Elec. distribution	5.00 – 6.00
Albury Gas Company [98]	Gas distribution	5.00 – 6.00
Electricity Networks & Retail Supply[99]	Elec. distribution/retail	5.00 – 6.00
NSW Rail[100]	Rail	5.00 – 6.00
Great Southern Energy [101]	Gas distribution	5.00 – 6.00
OffGAR:		
Parmelia Pipeline [102]	Gas transmission	6.00
Tubridgi Pipeline [103]	Gas transmission	6.00
Mid-west and South-West Pipeline[104]	Gas transmission	6.00
ORG:		
Victorian electricity distribution[105]	Elec. distribution	6.00
Victorian ports[106]	Ports	6.00
Victorian gas distribution[107]	Gas distribution	6.00
SAIPAR:		
South Australian gas distribution[108]	Gas distribution	6.00

[92] Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

[93] Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

[94] Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

[95] Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

[96] Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

[97] Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

[98] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

[99] Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

[100] Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

[101] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

[102] Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

[103] Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

[104] Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

[105] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

[106] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

[107] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

[108] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

Table 8: Market risk premium studies

Author	Country	Period	Equity Risk Premium (%)
Officer (1985)[109]	Australia	1882-1987	7.9
AGSM:[110]	Australia	1974-1983	6.3
	Australia	1977-1983	11.7
AGSM:[111]			
arithmetic average (incl Oct 1987)	Australia	1964-1995	6.2
arithmetic average (excl Oct 1987)	Australia	1964-1995	8.1
Reserve Bank of Australia[112]	Australia	n.a.	-1.9
Hathaway (1998)[113]	Australia	n.a.	6.6
Davis (1998)[114]	Australia	n.a.	4.5-7.0
Steering Committee on National Performance Monitoring of Government Trading Enterprises (1996)	Australia	n.a.	7.0
Brealey & Myers[115]	United States	1926-1988	8.4
Federal Reserve Bank of Minneapolis[116]	United States	1926-91	8.3
	United States	1981-91	7.7
Ibbotson and Associates[117,118]			
	United States	1926-29	17.6
		1930s	2.3
		1940s	8.0
		1950s	17.9
		1960s	4.2
		1970s	0.3
		1980s	7.9
		1990s	7.9
		1987-96	8.3
		1920s to 1990s	7.0
Office of the Rail Regulator[119,120]	United Kingdom	1919-1996	7.1
		1998	3.0 – 4.0

[109] Officer, R. (1985), 'Rates of Return to Shares, Bond Yields and Inflation Rates: An Historical Perspective', Chapter 14 in R. Brown, R. Ball, F. Finn and R. Officer (eds), *Share Markets and Portfolio Theory*, 2nd edition, UQ Press, Brisbane Australia.

[110] Centre for Research in Finance, Risk Management Service, AGSM, 1989. (Equity returns exclude property trusts and the premium is measured from the rate on short term Treasury notes. Property trust returns were higher).

[111] Independent Pricing & Regulatory Tribunal of NSW, The Rate of Return for Electricity Distribution Networks, November 1998.

[112] Richards, A. (1991), 'The Cost of Equity Capital in Australia: What can we Learn from International Equity Returns?' Reserve Bank of Australia Research Discussion Paper 9107.

[113] Hathaway, N. (1995), 'Market Risk Premium', Melbourne Business School seminar entitled Cost of Capital: Imputation, Credits and other Issues, Melbourne, 15 September.

[114] Davis, K. (1998), 'The Weighted Average Cost of Capital for the Gas Industry', report prepared for ACCC and the Office of the Regulator-General, March, pp. 13-14.

[115] Brealey, R. and S. Myers (1999), *Principles of Corporate Finance*, Sixth Edition, McGraw-Hill, New York, p. 136.

[116] Jagannathan, R. and E. McGrattan (1995), 'The CAPM Debate', *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 19 No. 4 Fall, pages 2-17.

[117] Annin, M. and D. Falaschetti (Ibbotson Associates) (1998), 'Equity Risk Premium Article', *Valuation Strategies*, January/February.

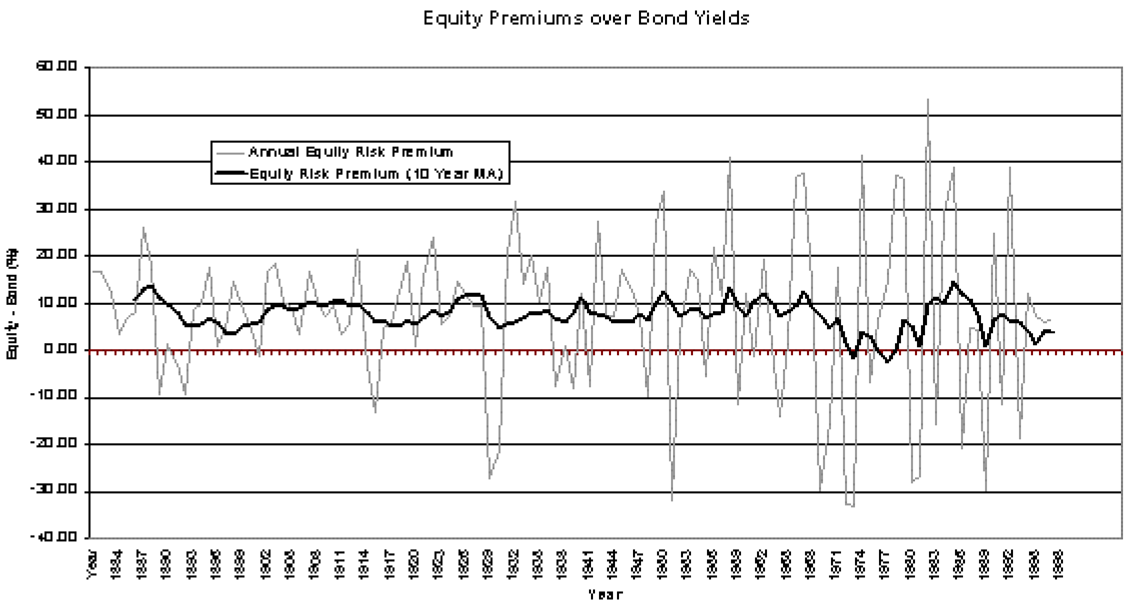
[118] Ibbotson Associates, 'Stocks, Bonds, Bills and Inflation Yearbook, 1996', quoted in Black, A., P. Wright and J. Bachman, 'In Search of Shareholder Value – Managing the Drivers of Performance', Price Waterhouse.

[119] UK Office of the Rail Regulator (1998), The Periodic Review of Railtrack's Access Charges: The Framework and Timetable and Further Consultation on Financial Issues (Second Consultation Paper).

[120] Office of Rail Regulator, The Periodic Review of Railtrack's Access Charges: The Regulator's Conclusions on the Financial Framework (Paper Three), December 1998.

The QCA is aware that there is a view among academics, market participants and regulators that the market risk premium has fallen over recent years, and is currently below that implied from its historical measurement.[121] The QCA calculated market risk premiums for the period 1888 to 1998 using Officer's method. Figure 4 shows a plot of the annual and the 10-year moving average market risk premium. It is noted that the 10-year average equity risk premium is relatively stable over the past century. This has occurred despite increased volatility in the annual market risk premium series and the change from regulated to deregulated financial markets over the past 25 years.

Figure 4



Kortian[122] observed that over the period 1928 to 1996, the Australian equity premium fluctuated between peaks in excess of 8% to levels as low as 1%. This may be attributed mainly to short term business cycles as measures of risk premium are influenced by the measurement period.[123] However, over longer periods, the results are fairly stable. Hathaway[124] found that the equity risk premium of the Australian equity market and world capital markets ranged between 6% to 7%, with the most likely estimate being 6.6%.

[121] This view was also identified by the ACCC in its NSW and ACT Transmission Revenue Caps 1999/00-2003/04 (January 2000) pages 20-22.

[122] Kortian, T. (1998), Australian Share Market Valuation and the Equity Premium, Department of Finance, University of Sydney.

[123] Fama, E. and K. French (1989), 'Business Conditions and Expected Returns on Stocks and Bonds', *Journal of Financial Economics*, vol. 25, pp. 23-49.

[124] Hathaway, N. and P. Dodd (1995), 'Government Cost of Capital – A Critical Look at the Treasury Model', draft paper Melbourne Business School seminar entitled Valuation and the Cost of Capital Under an Imputation System, Melbourne, 14 June.

Prior to the introduction of dividend imputation in July 1987, equity returns observed in the stock market represented rates of return after all corporate taxes had been paid (but before shareholder taxes were paid) and therefore could be used in determining the post-tax cost of equity funds for an entity. As noted by IPART:[125]

> "It has been suggested by some finance studies that the equity risk premium has reduced quite dramatically in recent years due to the effects of dividend imputation. In this view, a market risk premium calculated largely using data under a classical tax system [that is no imputation] of around 6 to 8 percent may be too high. Following the introduction of imputation, the risk premium could have fallen to reflect the additional value of franking credits received on an investment. However, it is argued by finance academia that whilst the mix of the components of expected returns may have altered, the aggregate expected return has not. The aggregate expected return is a function of the risk of the equity and it does not appear that the imputation tax system has changed this underlying risk."

The above argument is based on the assumption that the corporate rate of return is a function of the risk of the equity and the imputation tax system has not changed this underlying risk. Further, it may be argued that whilst the mix of the components of expected returns may have altered, the aggregate expected return has not.[126] The aggregate expected return is a function of the risk of the equity and the imputation tax system has not changed this underlying risk.

There is anecdotal understanding that share prices involving expectations of franked dividends have risen vis-à-vis other shares with the increase reflecting the credits to be realised through the tax system and not a reduction in the market risk premium for the investments. There is no conclusive empirical evidence to support the notion that dividend imputation has had a systematic effect on the market risk premium in recent years.[127] The impact of dividend imputation is discussed further in Appendix C.

During the 10-year window from 1988 to 1997 (after the introduction of dividend imputation), the annual equity risk premium was found to be between a high of 38.68% in the year ended 1993 and a low of –29.59% in the year ended 1990. The risk premium had an average of 3.89%.[128] Table 9 shows the average equity risk premium for each 10 year period from 1888 to 1997. The table provides an opportunity to compare pre-imputation periods with the 10-year period post imputation. Despite the movement in the mean values and the low correlation between the groups, statistical analysis shows that there is no conclusive evidence of any difference in the equity risk premium between prior 10-year periods relative to the period post-imputation.

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[125] Independent Pricing and Regulatory Tribunal of NSW, 'The Rate of Return for Electricity Distribution Networks: Discussion Paper', (November 1998), p16.

[126] Davis, K. (1998), 'The Weighted Average Cost of Capital for the Gas Industry', a report prepared for Australian Competition and Consumer Commission and the Office of Regulator-General, March, p. 14.

[127] Davis estimates that the market risk premium may have fallen following the introduction of dividend imputation in recognition of the additional value of franking credits. (Davis, K. (1998), 'The Weighted Average Cost of Capital for the Gas Industry', a report prepared for Australian Competition and Consumer Commission and the Office of Regulator-General, March, pp. 13-14). In contrast, Officer also supported the view that the market risk premium may be trending downward due to the prevailing stable inflationary environment but concluded that there is insufficient evidence to justify the equity risk premium has moved beyond the historical 6% to 8 % range (see ACCC, Victorian Gas Transmission Access Arrangements Final Decision, October 1998). Subsequently, in private correspondence (July 2000), Professor Officer indicated to the QCA that he now supports a range of 5-7% for the market risk premium.

[128] This figure is unadjusted for imputation. When the imputation uplift factor is included the market risk premium becomes 5.28%. See Appendix C. The standard deviation was 19.98% which highlights that extreme caution is warranted in interpreting these numbers.

Table 9: Comparison of average equity risk premiums

Period	Mean (%)
1888-1897	6.06
1898-1907	8.87
1908-1917	6.26
1918-1927	11.61
1928-1937	8.40
1938-1947	6.02
1948-1957	7.83
1958-1967	9.60
1968-1977	-0.07
1978-1987	11.82
1988-1997	3.89
	(5.28 when imputation credits are included with gamma set to 0.50)

As discussed above, the mean level of the equity risk premium during 1988 to 1997 is slightly lower than most earlier periods. However, this change from earlier periods cannot be attributed to dividend imputation alone. As discussed in Appendix C, this has also been a period of low interest rates, changes in demography, high levels of share ownership, low inflation and stability in the Australian economy, improved communications and technology decreasing information risks and increased institutional ownership of shares arising from changes in superannuation.

Historically, the market risk premium was considered to be in the range of 6% to 8 %. Clearly there has been a reduction in the market risk premium in recent years and there is evidence to suggest a lower range of between 5% to 7%. Following consideration of the submissions, recent regulatory trends and research undertaken by the QCA, the Authority considers the most appropriate estimate for the market risk premium is 6.00%.

4.3 The proportion of debt funding and capital structure

An entity's WACC recognises that its capital is provided by two sources, namely lenders and equity investors (owners or shareholders), and is equivalent to the weighted average cost of servicing the various classes of financial claims on the firm. Each source of capital or financial claim will involve different risks and hence different costs.

An entity's WACC is calculated by adding the cost of its debt, weighted by the proportion of debt to total assets, to the cost of equity funds weighted by the proportion of equity funds to total assets. The methodology requires estimates of the current market values of the firm's debt and equity and market rates for both sources of funds.

Capital structure refers to the relative weights of debt and equity that together finance the company's asset base. It is important in the assessment of both the cost of debt and the cost of equity. Typically, as the proportion of debt funding increases, the regulated business' risk profile changes. This increases both the cost of equity and the (lower) cost of debt.

The application of the WACC/CAPM model to the estimation of QR's cost of capital requires an assessment of QR's proposed gearing level in order to:

- calculate the relative weights to apply to the cost of equity and debt in the calculation of QR's WACC; and

- re-gear estimated asset betas to calculate QR's equity beta to be used in the calculation of the cost of equity funds.

In theory, two alternative approaches could be applied to the determination of the appropriate gearing level for the pricing of QR's infrastructure services:

- apply the actual gearing level that exists at a particular date; or
- apply an industry-based optimal capital structure.

However, it is generally accepted in finance theory that WACCs are approximately constant across a reasonable range of capital structures. This is because as the level of debt increases, the higher proportion of debt, which is at a lower rate than the cost of equity, offsets the effect of the higher cost of debt and equity.

Table 10 summarises the capital structures assumed in recent regulatory determinations in Australia. Regulators have most commonly assumed that the capital structure was composed of 60% debt financing (with a range of 50%-70% gearing). IPART[129] has noted that capital markets appear to regard a gearing level as high as 60% debt to total assets as acceptable, and are prepared to provide debt to a 60% geared business at a price commensurate with an investment grade rating (AAA to BBB).

Table 10: Capital structure

Regulatory Decision	Industry	Debt / (Debt + Equity) (%)
ACCC:		
Epic Energy [130]	Gas distribution	60
Central West Pipelines [131]	Gas distribution	60
Snowy Mountains Hydro Transmission network[132]	Electricity transmission	60
NSW & ACT Transmission networks[133]	Electricity transmission	60
IPART:		
AGL Gas Networks[134]	Gas distribution	60
NSW Electricity Distribution networks[135]	Electricity distribution	60
Albury Gas Company [136]	Gas distribution	60
Electricity Networks & Retail Supply[137]	Elec. distribution/retail	60
NSW Rail[138]	Rail	50 – 60

[129] Independent Pricing and Regulatory Tribunal of NSW: Aspects of the NSW Rail Access Regime (Final Report), April, 1999.

[130] Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

[131] Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

[132] Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

[133] Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

[134] Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

[135] Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

[136] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

[137] Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

[138] Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

Regulatory Decision	Industry	Debt / (Debt + Equity) (%)
Great Southern Energy [139]	Gas distribution	60
OffGAR:		
Parmelia Pipeline[140]	Gas transmission	60
Tubridgi Pipeline[141]	Gas transmission	60
Mid-west and South-West Pipeline[142]	Gas transmission	60
ORG:		
Victorian electricity distribution[143]	Electricity distribution	60
Victorian ports[144]	Ports	40
Victorian gas distribution[145]	Gas distribution	60
SAIPAR:		
South Australian gas distribution[146]	Gas distribution	60

According to QR's submission, the market value of its debt as at 30 June 1998 (after adjustments for certain provision accounts) yielded a gearing of 49%. QR's 1998-1999 Annual Report indicates that the percentage of total liabilities to total assets in 1999 was 66.18% and in 1998, 64.32%,[147] while interest bearing debt[148] to total assets was 42.91% in 1999 and 44.32% in 1998. In excess of 99% of QR's borrowing is long term. Each percentage is based on book as opposed to market values for debt and assets.

QR also acknowledged that Network Access' optimal capital structure may not equate with that of QR as a whole but QR's existing capital structure is a useful first point of reference. QR recommended a gearing range of 50-60% and adopted a mid-point of 55% for calculating the WACC for access pricing purposes.

Given that access charges are being calculated for a component of QR's below rail business on a stand alone basis, it is inevitable that the cost of capital is estimated by reference to a hypothetical capital structure. Moreover, using actual capital structures raises the question of how changes in the capital structure are to be factored into the WACC model, and at what point in time a capital structure is to be determined for input to the model. Accordingly, the QCA accepts that, within the limitations of the model, the assumed gearing should be consistent with an efficient financing structure, that is one that minimises the cost of capital.

[139] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

[140] Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

[141] Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

[142] Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

[143] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

[144] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

[145] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

[146] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

[147] This applies to all of QR's total business which incorporates QR's below rail coal network. Also, as the figures are taken from QR's balance sheet, it should be noted that total assets are measured in the balance sheet using historical rather than current cost method.

[148] This measure incorporates all borrowings, bank overdraft, and leases excluding operating leases. The ratio of total liabilities excluding provisions and operating leases to total assets was 47.07 in 1999 and 44.89 in 1998.

The calculation of an optimal capital structure based on an industry standard is difficult, especially given the limited number of comparable privately owned entities in Australia. The QCA notes that within a broad scope of 'commercial' capital structures, the cost of capital is not highly sensitive to small changes in capital structure.[149] The QCA therefore regards a gearing level between 50 to 60 percent as appropriate and accepts QR's proposal for its gearing level to be set at 55% for the purpose of assessing reference tariffs.

4.4 The cost of debt

The required return on debt is usually defined as the marginal rate at which an entity can raise debt financing, or in other words, the cost that the entity's debt holders demand on new borrowings. Unlike the cost of equity, the cost of debt can normally be observed either directly or indirectly, as interest rates can be observed in financial markets. The lender charges a premium on loans corresponding to the degree of default risk associated with the loan so that the cost of debt will vary depending on the default risk of the borrower.

This, in turn, will be affected by the gearing of the company (high gearing means a high level of debt relative to cash flows and consequently a higher risk of default), short term volatility of cash flows and long term security of revenue.

In estimating the cost of debt for regulatory purposes, the cost of debt needs to reflect the current market rate for debt for an entity that is efficiently financed. However it is important to note that under current government ownership, debt levels and regulatory structure, QR would obtain a higher debt rating than they would as stand alone entities due to an implicit Government guarantee. That is, the cost of debt would be higher without this implicit guarantee.

The QCA surveyed Australian regulators to ascertain the cost of debt margin adopted in recent regulatory decision in other jurisdictions. The results of this survey are summarised in Table 11.

[149] For example, the estimated WACC, as leverage increases from 0.50 to 0.60 (assuming an asset beta of 0.50 and a debt beta of 0.20), ranges from 9.25% to 9.28% (assuming the debt beta does not rise in response to higher gearing). However in reality, as the proportion of debt increases the cost of debt would also increase to reflect the higher leverage. This would result in a higher debt beta. The increased leverage would also result in a higher equity beta. However, as these adjustments occur, the WACC would remain unchanged.

Table 11: Cost of debt

Regulatory decision	Industry	Debt margin (%)
ACCC:		
Epic Energy [150]	Gas distribution	1.20
Central West Pipelines [151]	Gas distribution	1.20
Snowy Mountains Hydro Transmission Network[152]	Electricity transmission	1.00
NSW & ACT Transmission Networks[153]	Electricity transmission	1.00
IPART:		
AGL Gas Networks[154]	Gas distribution	0.90 – 1.10
NSW Electricity Distribution networks[155]	Electricity distribution	0.80 – 1.00
Albury Gas Company [156]	Gas distribution	0.90 – 1.10
Electricity Networks & Retail Supply[157]	Elec. distribution/retail	1.00
NSW Rail[158]	Rail	1.00
Great Southern Energy [159]	Gas distribution	1.20
OffGAR:		
Parmelia Pipeline [160]	Gas transmission	1.20
Tubridgi Pipeline [161]	Gas transmission	1.20
Mid-west and South-West Pipeline[162]	Gas transmission	2.00
ORG:		
Victorian electricity distribution[163]	Electricity distribution	1.50
Victorian ports[164]	Ports	1.20
Victorian gas distribution[165]	Gas distribution	1.20
SAIPAR:		
South Australian gas distribution[166]	Gas distribution	1.20

150 Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

151 Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

152 Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

153 Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

154 Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

155 Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

156 Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

157 Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

158 Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

159 Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

160 Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

161 Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

162 Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

163 Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

164 Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

165 Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

166 South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

In the majority of cases, the cost of debt applied to the regulated entity's WACC calculations was between 0.9 and 1.2% above the risk-free rate. However, care must be taken when interpreting these statistics as they apply to different entities with different capital structures and different risk profiles.

Broadly, there are two different approaches that may be taken to the estimation of the cost of debt, namely:

- a weighted average of the existing debt of the entity; and
- the marginal rate at which a company can raise debt financing which is represented by a margin over and above the risk-free rate.

The Authority notes that the use of actual cost of debt figures (either an average of actual costs, or the marginal cost of debt) has the benefit of reflecting those costs currently faced by the entities concerned. However, such an approach has the potential to entrench higher debt costs and does not create incentives to seek the most efficient form of financing, as it accepts the prevailing rate of debt even if it is not the most cost effective available. Accordingly, adopting a margin above the risk-free rate creates the incentive for the cost of debt to minimised. Moreover, it is not feasible to apply such an approach where a hypothetical capital structure has been assumed as QR has suggested.

The required return on debt is usually defined as the marginal rate at which an entity can raise debt financing. This rate will vary depending on the default risk of the borrower, which, in turn, will be affected by the gearing of the entity, the term to maturity of the debt and the volatility of its cash flows. High gearing means a high level of debt relative to the cash flows available to service it with a commensurate higher risk of default. The lender charges a premium on loans corresponding to the degree of default risk associated with the loan. In practice, this marginal rate can be estimated by referring to the interest rate premia associated with an assessed credit rating for the regulated business.

QR stated that the cost of debt for the purposes of estimating its rate of return should be based on an appropriate margin added to the risk-free rate used in the CAPM. QR, as a corporate entity, has previously been assessed in August 1997 by Standard and Poors (S&P)[167] with a BBB rating[168] on a stand-alone basis (without any government guarantees) and assumes that the same rating would be applied to the Network Access assets.[169] QR's analysis of current margins suggest that a BBB rating implies a margin of 120 basis points over the 3-year forward rate on the 10-year Commonwealth Government bond.[170] QR reaffirmed this position in November, 2000.

The Authority has considered the submission by QR's Network Access, the 1997 S&P report supplied by QR regarding its credit rating, examined the weighted average cost of debt for QR across all terms to maturity and has concluded that:

[167] No coal specific rating was undertaken by S&P.

[168] However, QR has increased its level of debt since the time of the report. Other things being equal, the effect of this debt increase would tend to suggest a deterioration in QR's credit rating.

[169] Typically government guarantees and debt pooling arrangements often associated with government borrowings afford government owned enterprises debt financing on better terms than their private sector counterparts.

[170] From the 1998-1999 QR Annual report it is noted that the weighted average cost of debt for QR (including the Government guarantee fee) on debt exceeding 5 years was 7.20%. At 30 June 1999 the 10-year Commonwealth Government 10-year bond rate was 6.27% indicating almost a 95 basis point premium for QR debt. The 5-year Commonwealth Government bond rate at 30 June 1999 was 5.90% indicating a difference of 130 basis points.

- the Authority has reservations about the recency of the S&P rating of BBB as it is over three years old. There is the possibility that a more recent analysis may produce a materially different credit rating in light of changes in the rail industry and Australian competition policy;

- the Authority has reservations about the application of the S&P rating of BBB for QR as a whole to QR's below rail coal network which is likely to exhibit the lowest business and financial risks of any of QR's businesses; and

- QR's proposed parameters for the assessment of its cost of capital for the purposes of estimating the rate of return depart materially from the book values of net assets and debt that would have underpinned the original S&P analysis.

QR proposed access charges for the use of its network for coal transportation be developed on the basis of the stand-alone cost of providing those services. The Authority therefore engaged Access Economics to undertake an independent assessment of how a credit ratings agency would most likely assess QR's below rail coal network relative to the remainder of its below rail business. The implicit Government guarantee was ignored for the purposes of this analysis.

Credit ratings are normally performed in a two stage process. The first stage is qualitative and assesses the level of business risk exhibited by an organisation (for example from excellent in the lowest risk quintile to vulnerable in the highest risk quintile). The second stage is the assessment of financial risk that is quantitative in nature involving a forecast of key parameters (such as interest cover) over a horizon (normally 5 years). The results of the quantitative assessment are then compared to benchmark ratios that are driven by the business risk assessment to arrive at a credit rating.

This assessment found that QR's below rail coal business risk was above average to excellent as compared with QR's Network Access as a whole, which was assessed as average. The business risk profile for QR's below rail coal business reflected its low risk as a natural monopoly business and the stability of its revenues given stable growth and the very low volume and price volatility to which it is exposed. These low risk characteristics were assessed to more than offset the relatively high risk associated with the comparatively high fixed cost nature of its operations.

The assessment undertaken departs materially from that which underpinned the S&P analysis since:

- the DORC valuation of QR's coal network was used to provide a proxy of QR's net assets instead of book values, which were depreciated historical costs; and

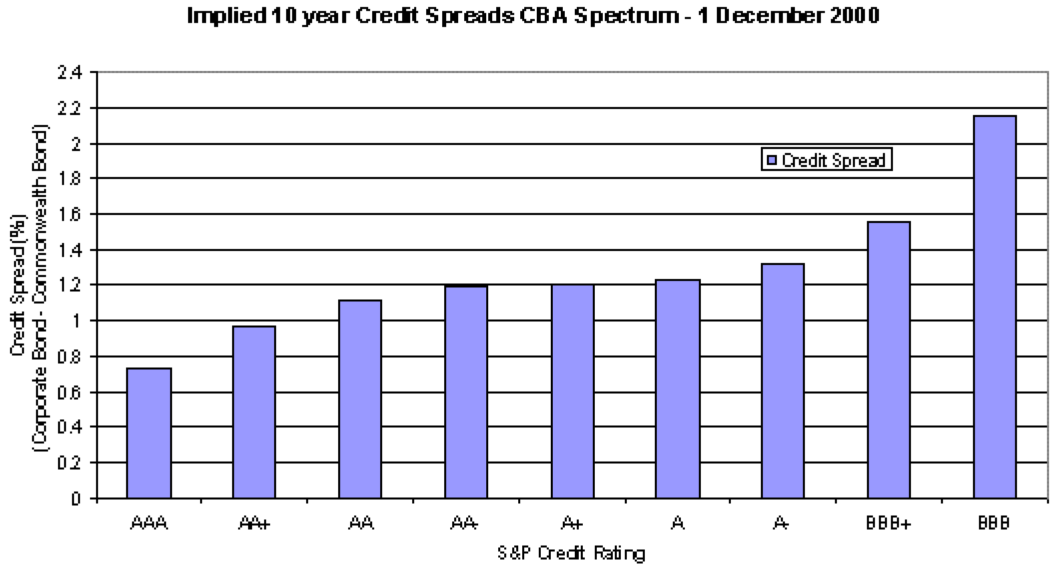
- QR's submission proposed a level of debt of 55% of net assets which is higher than its current capital structure (based on an apportionment of debt on the book values of assets) would imply.

Access Economics' advice was that QR's below rail coal business would most likely be assessed by an independent credit rating agency at a AA credit rating based on a book value apportionment of debt. However, on the basis of the parameters assumed for the review of QR's reference tariffs, the business was more likely to be assessed at an A rating.

Therefore, the Authority concludes that, despite QR's below rail coal business having a materially different risk profile to QR as a whole, an A rating is appropriate for these operations based on assumptions underpinning the assessment of QR's reference tariffs.

The Authority accepts that a 120 basis point margin falls within the range of the premia expected in debt markets for an A-rated entity. This is evidenced by data from the CBA spectrum which indicates, as depicted in Figure 5, implied 10-year credit spreads for a range of credit ratings.

Figure 5



4.5 Equity and asset betas

Introduction

There are two key determinants of an entity's equity beta:

- asset risk arising from the entity's sensitivity to cash flow movements – relative to overall economic activity, where more cyclical cash flows are associated with higher betas; and
- financial risk arising from financial leverage – the ratio of debt to equity, where a higher level of debt implies a higher beta.

An asset beta (β_a) represents the risk arising from the sensitivity of the operating cash flows generated by the assets of an entity compared with the market in general (that is, the market risk associated with an entity's assets). Asset betas vary with the volatility of free cash flows and are driven by sensitivity to the economy and operating leverage.

The difference between an asset beta and an equity beta reflects the additional financial risk to a shareholder arising from the extent to which debt is used to finance the entity's assets. Because debt holders have senior claims to the entity's cash flows and assets, equity holders face an additional risk. This financial risk increases as the level of debt in the organisation's capital structure rises. CAPM assumes that a linear relationship exists between an entity's gearing and the financial risk associated with that gearing.

Accordingly, it is asset rather than equity betas that should be compared for the purposes of benchmarking risk. This is because equity betas are affected by the gearing of the entity under review whereas asset betas are not (an entity's asset and equity beta will be identical if it is 100% equity financed).

However, asset betas are not directly observable whereas equity betas can be estimated by undertaking a regression analysis of a security's returns relative to the market as a whole. Asset betas can only be derived from equity betas by separating that beta into the financial risk from an organisation's capital structure and the underlying risk of its assets. This later component then forms the asset beta that may be used for benchmarking purposes. Since CAPM assumes a linear relationship between financial risk and gearing, asset betas can be derived from equity betas.

Accordingly, estimating an equity beta for an organisation that is not listed involves the following steps:

- estimate equity betas for comparable organisations;
- de-lever these equity betas to derive asset betas;
- assess the subject organisation's asset beta based on a comparison with the other derived asset betas; and
- once an asset beta has been estimated for the subject organisation, re-lever that asset beta to derive an equity beta for the subject organisation.

For entities with no traded equity, like most government business activities, it is necessary to use judgement in determining the appropriate equity betas to be used in the estimation of the required return on equity funds.[171] In practice, this process requires judgment be exercised based on commercial experience and understanding rather than rigid adherence to a particular financial concept.

As is the case for entities with traded equity, equity betas used in calculating WACCs for government businesses should reflect the perceived undiversifiable risk involved in that business. However, as noted by the Industry Commission in 1996:[172]

> "The impact of beta estimates on the cost of capital is often overemphasised. Dividend imputation, changes in the risk-free rate, assumptions regarding the size of the market risk premium and the rounding of targets, can all have a greater impact on the estimation of cost of capital than a minor adjustment to the equity beta."

Issues in the estimation of QR's below rail coal equity beta

To assist in estimating QR's below rail coal network beta (whether equity or asset), the following may be considered as reference points:

- the industry which QR's below rail coal business serves;
- overseas listed rail and transport companies;
- comparable Australian companies listed on the Australian Stock Exchange (ASX), as well as listed companies that have a similar risk profile;
- views expressed by regulatory bodies, such as IPART, on comparable entities (for instance the Rail Access Corporation); and

[171] The associated increase in subjectivity which results does not lessen the fact that the cost of equity capital should still reflect the rate of return required by a shareholder.
[172] Steering Committee on National Performance Monitoring of Government Trading Enterprises (1996), 'An Economic Framework for Assessing the Financial Performance of Government Trading Enterprises', Industry Commission, Melbourne.

- an analysis of the volatility of QR's below rail coal network cash flows.

The WACC relationship expresses the entity's cost of capital as the weighted average of the required return on its equity and debt. Because of the equivalence between the assets of the entity to a portfolio of the entity's equity and debt with respective weights of $\frac{E}{E+D}$ for equity and $\frac{D}{E+D}$ for debt, the return on assets can be expressed as follows:

$$R_a = R_e\left(\frac{E}{E+D}\right) + R_d\left(\frac{D}{E+D}\right)$$

By substituting CAPM for each of the returns (R_a, R_e and R_d), it is possible to express the above equation in terms of the relationship between the asset, debt and equity betas as follows:[173]

$$\beta_a = \beta_e\left(\frac{E}{D+E}\right) + \beta_d\left(\frac{D}{D+E}\right)$$

where

β_a is the asset beta

β_e is the equity beta

β_d is the debt beta

Typically, equity betas (β_e) are estimated using historical data through the application of the market model expressed as follows:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}$$

where

$R_{i,t}$ is the return on security i at time a point in time t

$R_{m,t}$ is the return on the market portfolio at a point in time t

α is a constant term that measures the portion of the return on security i that is not related to or influenced by the market return

β represents the estimated beta coefficient and represents the sensitivity of the security's return to changes in the market return

$\varepsilon_{i,t}$ is the error term that represents the portion of the security's return that is not captured by α_i and β_i

The debt beta (β_d) reflects the financial risk borne by shareholders due to the entity's use of debt financing. The CAPM can be used to identify the debt beta as follows.

$$R_d = R_f + \beta_d\left[R_m - R_f\right]$$

Transformed :

$$\beta_d = \frac{R_d - R_f}{\left[R_m - R_f\right]}$$

[173] Due to the implied linear relationship between the betas this equation can also be expressed in terms of both the equity and debt beta. Thus any increase in the underlying asset beta, assuming the debt beta is constant will result in an increase in the equity beta. Similarly any increase in the equity betas will have a corresponding increase in the asset beta.

Accordingly, the beta of an entity's assets is equal to the betas of the entity's equity and debt weighted by the respective levels of equity and debt. Whilst equity and debt betas can be calculated via CAPM-based methods, the asset beta can only be inferred via the above relationship.[174] Appendix D discusses the equity, debt and asset betas in more detail and identifies issues in their calculation.

The first concern arises in measurement error and the tendency of some equity betas to move toward 1 over time (due to growth or diversification).[175] These factors have caused some data providers to adjust the raw equity betas generated by regression analysis. The adjustment approach applied by Bloomberg is as follows[176]:

Adjusted beta = 0.33 + raw beta x *0.67.*

The Authority notes the lack of conclusive evidence supporting the use of adjusted betas. The procedure has a number of inconsistencies in its implementation which suggests the use of adjusted equity betas is not without significant problems. These include:

- adjusted betas can potentially overstate (understate) the asset beta of low (high) raw equity beta firms (depending if the assumptions underlying the beta adjustment are justified in the particular case). For example, assume an entity has a raw equity beta of 0.39, debt to equity ratio of 0.50, debt beta of 0.12 and a corresponding asset beta of 0.30. The entity's adjusted equity beta is equal to 0.59. This equity beta corresponds with an asset beta of 0.43.[177] The adjustment for this relatively low equity beta firm is disproportionate when compared to a firm with an equity beta close to 1;[178]

- the implementation of the adjustment procedure does not consider the level of leverage held that is used by the firm – low leverage firms may substitute debt for equity over time thereby increasing the equity beta without increasing its business risk. For example, if the entity described above was 100% equity financed, with a raw equity beta of 0.39, this would correspond to a raw asset beta of 0.39. However, using the beta adjustment would increase the equity beta to 0.59 which corresponds to an adjusted asset beta of 0.59; and

- the adjustment does not consider that long established pure-play businesses such as QR's below rail coal network would be unlikely to increase their business risk over time to a higher equity beta. Indeed, adjusting the equity beta on the basis of future diversification and growth is somewhat inconsistent with the stand-alone basis of the proposed assessment of QR's below rail coal business.

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[174] Gearing used in the de-levering of equity betas is normally taken as the book value of debt divided by the book value of debt plus the market value of equity (market capitalisation). The Authority used the following active debt management approach to de-lever and re-lever equity betas:

$$b_a = \frac{b_e + b_d \times \frac{D}{E}}{1 + \frac{D}{E}} \quad \text{and} \quad b_e = b_a + (b_a - b_d) \times \frac{D}{E}$$

Alternative approaches are discussed in Appendix D.

[175] Over time, high betas tend to move down and low betas tend to move up. This issue is discussed further in Appendix D of working paper 4.

[176] Once the adjusted beta is calculated an implied adjusted asset beta can be delevered using the approach detailed in the above footnote.

[177] The figures in this example correspond with calculations undertaken for the coal mining company Centennial Coal Company Ltd. The difference between these asset betas yields a margin of approximately 0.8% for the company's weighted average cost of capital in absolute terms or about 10% in relative terms.

[178] For example, consider an entity with the higher raw equity beta at 1.05, debt to equity ratio at 0.40, debt beta of 0.06 and an asset beta of 0.77. This firm has an adjusted equity beta of 1.03 and a corresponding asset beta of 0.75. The figures in this example correspond with calculations undertaken for the transport company Toll Holding Ltd.

The difficulties outlined above merely serve to highlight that the calculation of WACC using CAPM to estimate the return on equity involves some degree of imprecision. However, the Authority considers that in applying CAPM in a regulatory setting, regard must be had to the risks of allowing too low a rate of return in the sense that considerably more social harm could be caused by de-selecting too low a rate of return (leading to no investment in the network) than one that is at the upper bound of a reasonable range. Consequently, the Authority proposes to consider adjusted (as well as raw) betas in the assessment of QR's rate of return for its below rail coal business.

Identification of comparable data

Australian rail data - there are no publicly listed rail companies in Australia. The closest available rail beta data are available for:

- Rail Access Corporation (RAC); and
- Westrail.

The RAC in New South Wales emerged from the vertical separation of the former State Rail Authority. RAC owns all the essential public rail infrastructure assets, including track, overhead wiring, signals and support systems. IPART reported an equity beta in the range of 0.70 to 1.0[179] and an asset beta of 0.29-0.55 for NSW rail infrastructure.

The West Australian Government Railways Commission (Westrail) in Western Australia was established under the Government Railways Act 1904 to direct, manage, maintain and control the government owned railways in Western Australia. Westrail's main areas of activity are in respect of rail freight, passenger transport and infrastructure services and they are responsible for providing railway track access rights and other services to freight and passenger railway service operators. Macquarie Bank, in a report prepared for the Western Australia Government, identified an equity beta in the range of 0.9 to 1.1 for Westrail's freight infrastructure.[180]

RAC and QR have in common a similar sized rail network, and high percentage of use of the network for coal haulage relative to other freight movements. In contrast, Westrail has a smaller rail network and transports only 30% of the freight volume transported by QR with less than 3% of that freight comprising coal for domestic electricity.[181] It should also be noted that the total assets of QR are significantly larger than RAC and Westrail. This would suggest that QR's below rail coal business would have a lower equity beta.

Overseas rail data - as there are no listed Australian rail companies, overseas rail companies may be relied upon for guidance. However, it is noted that international betas are not directly comparable to Australian betas and extreme care must be taken in their interpretation.[182] The following companies from the United Kingdom (UK) and United States of America (US) were considered:

[179] The equity betas were calculated by IPART following consideration of estimates of equity betas from interested parties, Railtrack PLC (UK), US rail companies and consideration of RAC specific factors effecting systematic risk. IPART considered that the risks faced by RAC were below the market average. No consideration was made of the delevered asset betas of the comparable entities.
[180] An asset beta was not provided.
[181] The RAC network is used for a considerably higher number of passenger services (236 million compared with Westail's 29 million and QR's 42 million in 1998-99).
[182] This issue is discussed further in Appendix D.

- from the UK, Railtrack PLC; and
- from the US, Burlington Northern Sante Fe Corporation (BNSF), CSX Corporation (CSX), Norfolk Southern Corporation (NSC) and Union Pacific Corporation (UPC)[183].

Railtrack PLC is the owner and operator of all UK national below rail infrastructure, which includes:[184]

- 32,000 kilometres of track and associated signalling and electrical control equipment, providing a network of more than 16,000 route kilometres;
- 40,000 bridges, tunnels and viaducts;
- 9,000 level crossings;
- 2,500 stations - Railtrack is both facility provider and developer at a number of major stations, leasing space to retailers ranging from booksellers to fast food chains. With the exception of 14 major stations which Railtrack operates, all stations and depots are leased to train operators;
- 90 light maintenance depots – Railtrack is responsible for maintenance and repair, renewal of track, stations, signalling and electrical control equipment and enhancement of the network; and
- over 1,000 freight terminals.

Railtrack PLC had a market capitalisation of £4.954 billion in June 2000 and sourced 100% of its revenue from railway operations. Table 12 details the major sources of Railtrack's revenue. This table highlights that Railtrack overwhelmingly serves passenger as opposed to freight traffic.

Table 12: Breakdown of Railtrack PLC's revenue

Source of turnover:	**Year ended 31 March (2000 £ millions)**	**% of total turnover**
Passenger franchise revenue	2,175	85
Freight revenue	158	6
Property rental income	135	5
Other income	79	4
Total	2,547	100

Source: Railtrack PLC Annual Preliminary results for year ending March 2000 at http://www.railtrack.co.uk/shareholder/fin_reports/index.html

[183] These companies account for over 86% of total operating revenues and over 87% of railroad assets of all Class-1 railroads. They were selected based on the following criteria:

- the company is listed on either the New York or American Stock Exchange;
- the company paid dividends throughout the year;
- the company's rail assets are greater than 50% of total assets; and
- the company has a debt rating of at least BBB (Standard & Poor's) and Baa (Moody's).

These companies account for over 86% of total operating revenues and over 87% of railroad assets of all Class 1 railroads. Another class 1 railway Kansas City Southern Industries (KCSI) was excluded from the analysis as it did not meet the above criteria. Almost 52% of the KCSI is derived from activities in the financial services industry.

[184] See http://www.discover.railtrack.co.uk/frame.html.

Burlington Northern Sante Fe Corporation (BNSF), CSX Corporation (CSX), Norfolk Southern Corporation (NSC) and Union Pacific Corporation (UPC) are almost entirely freight railways with heavy trains travelling long distances. The industry is typically vertically integrated with track operators owning the above and below-rail assets. The market for rail freight transport in the US is entirely deregulated, highly competitive and there is limited oversight by the Surface Transportation Board over rates charged on freight, conditions of access and mergers.[185]

As illustrated in Table 13, Burlington Northern Sante Fe Corporation (BNSF) is the only US corporation in the sample of US companies examined that is focused solely on rail related activities. Over 90% of Union Pacific's revenue is also sourced from rail activities. The other corporations have activities which vary from real estate related operations to other forms of transportation such as shipping. Whereas QR sources over 56% of its revenue from coal and mainline freight,[186] US based companies only derive an average of 24.60% of their revenue from coal. Moreover, the haulage of coal by these railroads is predominantly for domestic electricity generation, which is a very different market to the export markets served by QR.

Table 13: US Class 1 railway companies

US rail companies	Market capitalisation US$ Bn[187]	Network route kilometres	% of revenue sourced from railway operations	% coal haulage
Burlington Northern Santa Fe Corp[188]	8.4	53,600	100%	24%
CSX Corporation[189]	4.8	37,440	52%	32%
Norfolk Southern Corporation[190]	5.9	34,880	86.2%	25%
Union Pacific Corporation[191]	9.4	56,000	91%	25%

There are the following significant differences between US and UK rail companies and QR's coal-related below-rail assets:

- different stock markets and macroeconomic conditions. Differences in market composition of national share markets do not facilitate direct comparison of betas;[192]

- differing regulatory regimes. The US rail industry is characterised by privately-owned vertically-integrated organisations. Generally rates and service terms are established by commercial contract. The economic regulation of the US rail industry is undertaken by the Surface Transportation Board (STB)[193] and focuses on constrained market pricing for captive shippers of above and below rail components of the service;

- variations in industry structure and levels of competition - the Australian and Queensland transportation market is a substantially smaller industry compared with that in the US and UK;

[185] Organisation for Economic Co-operation and Development (1995), Proceedings of the OECD/World Bank Conference on Competition and Regulation in Network Infrastructure Industries, Paris 1995, OECD/GD(95)87, pp. 256 and 276.
[186] See Note 2 in the Notes to and forming part of the Financial Statements, QR 1998-1999 Annual Report.
[187] Market capitalisation as at 22 September 2000. Source: Bloomberg website: www.bloomberg.com.
[188] Burlington Northern Sante Fe Corporation 1999 Annual report and website: www.bnsf.com.
[189] CSX Corporation 1999 Annual report and website: www.csx.com.
[190] Norfolk Southern Corporation's 1999 Annual report and website: www.nscorp.com.
[191] Union Pacific Railroad December 1999 4th quarter earnings supplement and website: www.uprr.com.
[192] Discussed in detail in Appendix D.
[193] The STB is responsible for the economic regulation of surface transport and adjudicates disputes and regulates interstate surface transportation, including railroad rate and service issues.

- variations in the level of non-rail activities within entities - the US rail companies in particular tend to be diversified organisations with a range of different businesses. In contrast, neither QR's below rail coal network nor Railtrack engages in non-rail activities;

- differing operating environments - as illustrated in Table 14, US and UK rail companies are significantly larger than QR in terms of their scope of activities. In addition, US Class-1 rail companies transport around 33% of total volume of commodities transported, which is significantly less than QR's coal dedicated below rail infrastructure in question. In addition, the bulk of coal haulage activities of US railroads relate to thermal coal used for domestic electricity generation, a completely different market to that served by Queensland export coal; and

Table 14: Coal volumes

Organisation	Coal volumes as a % of total volume of freight[194]
Australia	
QR	86.74
RAC	84
Westrail	2
UK	
Railtrack PLC	n.a.[195]
US	
Burlington Northern Santa Fe Corp	33.3
CSX Corporation	29.1
Norfolk Southern Corporation	30.1
Union Pacific Corporation	25.9
Average Class 1 railroads	32.6[196]

- geographical composition - given the location of QR's below rail assets in remote areas, there is little scope for operators to broaden services to include activities such as passenger or freight. It is expected however that there will be continued strong growth for QR's below rail coal network given the industry that it serves. In contrast, US coal deposits are usually in isolated areas with ultimate destinations predominantly being electricity utilities distributed across the country. The population density in the US and UK is significantly higher than Australia, which gives rise to greater capacity for US and UK above rail operators to take advantage of economies of scale and scope. However, changes in freight infrastructure technology and competing modes of transport are unlikely to pose a significant risk of obsolescence in the foreseeable future. Therefore the geographic and demographic characteristics of the location of QR's below rail infrastructure are offset by QR's advantages over alternative forms of transportation.

Australian, UK and US rail sector equity and asset betas - betas on rail sector entities are reported in Table 15. Care should be taken in interpreting these statistics, since Australian and international betas are not directly comparable.

[194] Source of coal volumes as a percentage of total volume of commodities transported by US rail companies: Association of American Railroads quoted in US Investment Research on Wisconsin Central by Morgan Stanley Dean Witter of 21 July 1998 (page 18).
[195] Total freight revenues only accounted for 7% of all revenues – no coal was transported.
[196] This figure includes Kansas City Southern Industries (KSCI) at 25.9%.

Table 15: Rail entity equity and asset betas

Organisation	Equity Beta (b_e)	Asset Beta (b_a)
Australia		
IPART – NSW Rail Access Corporation[197]	0.7-1.0	0.29-0.55
WA Department of Transport – Westrail freight infrastructure[198]	0.9-1.1	n.a.
United Kingdom		
Railtrack – London Business School Risk Measurement Service [199]	0.61	0.53
Railtrack – Office of Rail Regulation[200]	0.75-0.85	0.70-0.80
United States		
Bloomberg – class 1 rail companies:[201]		
Burlington Northern Santa Fe Corporation	0.70	0.48
CSX Corporation	0.87	0.44
Norfolk Southern Corporation	1.01	0.50
Union Pacific Corporation	0.76	0.52
New York University – rail sector[202]	0.87	0.59[204]
Ibbotson Associates – rail sector[203]	1.13	n.a.

From the table it is noted that the equity betas on reported Australian rail entities are between 0.70 and 1.1, UK rail entities between 0.75 to 0.85 and US rail entities between 0.70 and 1.01. Asset betas on Australian entity's are between 0.29 to 0.55, UK entities from 0.53 to 0.80 and US entities, de-levered from raw equity betas, ranged from 0.44 to 0.52. The results reflect the diversity of features discussed above.

Alternative transport

Despite the absence of a rail company listed on the Australian Stock exchange there are several listed companies involved in transportation activities – companies such as Brambles, Heggies Bulkhaul, Toll Holdings, K&S Corporation and Qantas.[205] The Australian industry is dominated by Brambles with a capitalisation in excess of $9.5 billion. With the exception of Qantas ($4 billion) and Toll Holdings ($515 million) most other transportation companies have capitalisations of less than $100 million.

[197] IPART, Aspects of the NSW Rail Access Regime (Final Report), April 1999, pages 59 to 60.
[198] Macquarie Bank Limited, Independent Assessment of Maximum Rate of Return on Rail Infrastructure – Draft Report, 9 July 1999, commissioned by the Western Australian Department of Transport, pages 17 to 22.
[199] London Business School Risk Measurement Service, December 1999 – referred to in The Periodic Review of Railtrack's Access Charges: The Regulator's Conclusions on the Financial Framework by the Office of Rail Regulator of April 2000, http://www.rail-reg.gov.uk.
[200] Office of Rail Regulator, The Periodic Review of Railtrack's Access Charges: The Regulator's Conclusions on the Financial Framework (Paper Three), December 1998, http://www.rail-reg.gov.uk.
[201] Bloomberg (2000). These beta estimates are based on 60 monthly observations over the period 31 March 1995 to 31 March 2000.
[202] Damodaran, A. (1998), *Betas and Un-levered Betas by Industry at 31 December 1998*, Stern School of Business, New York University.
[203] Kaplan, P.D. and Peterson, J.D. (1997), 'Full-information Industry Betas', Ibbotson Associates.
[204] Domodaran reports an asset beta of 0.65 and an industry average debt to equity ratio of 48.46%. This figure was calculated using the Brealey Myers approach.
[205] Finemore Holdings Ltd announced on 27 June 2000 a takeover by Toll Holdings Ltd. As a result Finemore Holdings was excluded from the sample, as the share price of Finemore Holdings Ltd increased from $1.28 to $2.20 between May 2000 to June 2000 and the equity beta increased from 0.95 (31 May 2000) to 1.39 (31 August 2000). The asset beta for Finemore Holdings Ltd at 31 May 2000 was 0.80 but had increased to 1.16 at 31 August 2000.

Table 16 lists the equity and asset betas of several of these transport companies.

Table 16: Australian ASX-listed transport companies

Organisation	Equity beta (b_e)	Asset beta (b_a)
ASX transport sector [206]		
Brambles Ltd	0.81	0.72
Heggies Bulkhaul Ltd	0.76	0.51
K&S Corporation Ltd	0.39	0.32
Qantas Ltd	0.41	0.24
Toll Holdings Ltd	1.03	0.75

The earnings of most of the road transportation companies listed on the Australian Stock Exchange are sensitive to movements in the domestic economy, suggesting that they exhibit significant undiversifiable risk which is reflected in their equity and asset betas. In addition, many of the road transport companies have significant undiversified risk which would affect their betas materially. In contrast, both Brambles and Qantas's earnings are also conditional on world economic growth due to their international operations.

Asset betas de-levered from adjusted equity betas range from 0.24 to 0.75.

QR's below rail coal network has very little exposure to the domestic economic environment in contrast to many of these transport companies. Hence it would be expected that their equity betas would be regarded in the upper limit group of QR's asset beta for the provision of access for coal transport.

Coal-based mining companies

Table 17 reports the equity and asset betas for companies in the coal mining sector listed on the Australian Stock Exchange. Asset betas de-levered from adjusted equity betas were in the range of 0.39 to 0.84, with the majority of coal mining companies at or below 0.61.

Table 17: Australian ASX-listed coal mining companies

Organisation	Equity beta (b_e)	Asset beta (b_a)
ASX Australian coal companies[207]		
Austral Coal Limited[208]	0.60	0.60
Centennial Coal Company Limited	0.59	0.43
CIM Resources Limited	1.19	0.57
Coal and Allied Industries Limited	0.40	0.39
Cumnock Coal Limited	0.75	0.61
QCT Resources Limited	1.11	0.84

Whilst it could also be argued that coal freight companies face the same risks as the coal companies in their exposure to world coal markets,[209] in practice this is unlikely to be the case due to:

[206] Bloomberg (2000). These beta estimates are based on 60 monthly observations over the period 31 August 1995 to 31 August 2000.
[207] Bloomberg (2000). These beta estimates are based on 60 monthly observations over the period 31 August 1995 to 31 August 2000.
[208] The equity beta of Austral Coal Limited was calculated with only 39 observations.

- the considerably lower price risk for coal rail transport. QR's coal business is not directly exposed to fluctuations in world coal prices. Moreover, its indirect exposure is very small. For example access charges for each tonne of coal will constitute, on average, less than 5% to the average coal price; and

- volume risk has been mitigated from take or pay contractual arrangements, and the regulatory environment.[210]

QCA research revealed that each of the coal companies could be differentiated with respect to their contractual arrangements,[211] mine and operational performance and cost competitiveness. Considering each of these factors, it was considered that Centennial Coal Company Ltd was the most representative of the coal companies.[212]

Analysis of the annual reports of each of the listed coal companies revealed that Centennial had the least exposure to the world price of coal. This is because approximately 48% of Centennial sales are made under long term contracts to domestic electricity generators, down from 57% in 1998.[213] Under these contracts, volumes are certain and a fixed base price is subject to indexation. Hence, the sales revenue generated under such contracts is highly uniform and predictable and most closely resembles the relative earnings stability that QR's below rail coal business is likely to exhibit.[214]

In contrast, QCT Resources Ltd's output was exposed to both price and volume risk from its contractual arrangements with respect to international coal sales. Long-term export contracts are generally subject to annual price and volume negotiations. Price and revenue volatility under these contracts has consequently been much higher than has been the case for domestic utility contracts with certain volumes and prices indexed to CPI. Price volatility on export markets is further exacerbated by the increasing proportions of export volumes that are sold under short-term contracts and into spot tenders.

The company has experienced problems in mine performance, particularly over the past year when output from the Kenmare longwall operation has been severely impacted by faulting and associated ground control problems in both seams mined. Also, QCT's coal assets were held as minority interests in joint ventures. As a result QCT Resources has experienced increased volatility in its earnings and share price since December 1998. The company has also been subject to speculation as a takeover target, culminating in BHP's recently successful takeover of the company.[215]

[209] Industry Commission (1991), Choosing the Appropriate Rate of Return for Coal Rail Investment (Appendix J of Rail Transport Report page 122).
[210] Chapter 16 sets out the circumstances in which QR's
[211] In particular the proportion of sales into long term domestic contracts versus exposure to price and volume risk in international contracts.
[212] Other Australian coal companies considered, but dismissed for comparative purposes, include Austral (small company), Coal and Allied (thinly traded with majority shareholder controlling nearly 99% of shares) and Cumnock and CIM, both of which exhibited highly unstable betas.
[213] The transition during 1999 followed the acquisition of Clarence Colliery where production was committed to premium export markets.
[214] Centennial also has a history of consistent performance in its mining operations.
[215] Analysis of QCT Resources' equity beta by the Authority found that, since December 1998, the raw equity beta of QCT Resources has jumped from under 0.80 to over 1.20. Decomposition of the equity beta into its covariance and variance components revealed that most of the increase is attributable to increased volatility of QCT Resources share price following the redemption of its preference shares in December 1998.

As a result, the Authority considers that QCT Resources is not representative of the Queensland coal industry and that Centennial provides a more appropriate proxy for QR's below rail coal business.[216] However, there are two important reasons why it might be expected that QR's stand-alone below-rail coal business would exhibit a materially lower undiversifiable risk (and hence asset beta) than Centennial:

- QR's cash inflows have significantly less exposure to the international coal market; and
- Centennial Coal is a significantly smaller company than QR's below-rail coal network. As noted in Appendix D, empirical evidence suggests that there is an inverse correlation between market capitalisation and systematic risk (beta). That is, smaller entities tend to have higher betas than larger entities.[217]

Therefore, shareholders would expect that if QR's below rail networks had identical leverage to Centennial Coal, its equity beta should lie below the beta for Centennial Coal.

Utilities and infrastructure

Tables 18, 19 and 20 report the equity and asset betas for US industry averages, a number of Australian infrastructure and utility firms and regulatory body decisions. Once again, caution must be exercised in comparing Australian and international betas.

Table 18: Equity and asset betas –US infrastructure and utility firms

Industry	**Equity beta (β_e)**	**Asset beta (β_a)**
United States		
New York University[218]		
Electric utility (central)	0.53	0.27
Electric utility (east)	0.54	0.23
Electric utility (west)	0.56	0.31
Natural gas (distribution)	0.59	0.34
Natural gas (diversified)	0.82	0.34
Water utility	0.55	0.31

[216] Examination of the equity ownership of each of the coal companies also reveals that Centennial also has the most diversified ownership with the top 20 shareholders holding less than 27% of the shares. This contrasts directly with the other companies which are more narrowly held (for example Austral 63.40%, Coal & Allied 98.90%, Cumnock 99.49% and QCT Resources 69.88%).

[217] Berk, J.B. (1995), 'A Critique of Size-related Abnormalities', *Review of Financial Studies*, (Summer), pp. 275-286.

[218] Damodaran, A. (1998), Stern School of Business, New York University – Betas and Unlevered Betas by Industry at 31 December 1998.

Table 19: Equity and asset betas – Australian listed companies and regulatory decisions

ASX infrastructure & utilities companies[219]	Industry	Equity Beta (b_e)	Asset Beta (b_a)
Allgas Energy Limited[220]	Gas	0.50	0.48
Australian Gas Light Ltd	Gas	0.73	0.58
Energy Developments Ltd	Electricity	1.15	0.81
Envestra Ltd[221]	Gas	0.48	0.12
Hills Motorway Group[222]	Tollway	0.71	n.a.
Transurban City Link Limited[223]	Tollway	0.77	n.a.
United Energy Ltd[224]	Electricity	0.85	0.42

Table 20: Equity and asset betas – regulatory decisions

Regulatory Decision	Industry	Equity beta	Asset beta
ACCC:			
Victorian Gas Transmission Final Decision[225]	Gas transmission	1.20	0.55
Epic Energy[226]	Gas distribution	1.16	0.50
Central West Pipelines[227]	Gas distribution	1.48	0.60
Snowy Mountains Hydro Trans. Network[228]	Elec. transmission	1.00	0.42
NSW & ACT Transmission networks[229]	Elec. transmission	0.78-1.25	0.35-0.50
IPART:			
AGL Gas Networks[230]	Gas distribution	0.90-1.10	0.40-0.50
NSW Electricity Distribution networks[231]	Elec distribution	0.78-1.14	0.35-0.50
Albury Gas Company[232]	Gas distribution	0.90-1.10	0.40-0.50
Electricity Networks & Retail Supply[233]	El. distrib'n/retail	0.77-1.14	0.35-0.50
NSW Rail[234]	Rail	0.70-1.00	0.29-0.55

219 Bloomberg (2000). These beta estimates are based on 60 monthly observations over the period 31 August 1995 to 31 August 2000.
220 The equity beta of Allgas Energy Ltd was calculated with 60 observations measured from 31 August 1993 to 31 August 1998.
221 The equity beta of Envestra Ltd was calculated with only 36 monthly observations.
222 The asset beta for the Hills Motorway group was not calculated due to the 14.62% cost of debt reported in its annual report – this rate would imply a debt beta in excess of 1.50 which is higher than the firms equity beta. This highlights that the market valuation of Hill's Motorway's debt is significantly lower than the reported book value of its debt.
223 The equity beta of Transurban City Link Limited was calculated with only 53 observations. The asset beta for Transurban was not calculated due to the 11.20% cost of debt reported in its annual report – this rate would imply a debt beta in excess of 0.78 which is higher than the firms equity beta at 0.77. This highlights that the market valuation of Transurban's debt is significantly lower than the reported book value of its debt.
224 The equity beta of United Energy Ltd was calculated with only 27 observations.
225 Australian Competition and Consumer Commission, Final Decision on the Victorian Gas Access Arrangements for Multinet, Westar and Stratus, 6 October 1998.
226 Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000
227 Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000
228 Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000
229 Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000
230 Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000
231 Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999
232 Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999
233 Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999
234 Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

Regulatory Decision	Industry	Equity beta	Asset beta
Great Southern Energy [235]	Gas distribution	0.96-1.00	0.40-0.50
OffGAR:			
Parmelia Pipeline[236]	Gas transmission	0.65	1.00
Tubridgi Pipeline[237]	Gas transmission	0.65	1.33
Mid-west and South-West Pipeline[238]	Gas transmission	0.55	1.20
ORG:			
Victorian electricity distribution[239]	Elec distribution	1.00	0.40
Victorian ports[240]	Ports	0.70-0.87	0.50-0.60
Victorian gas distribution[241]	Gas distribution	1.20	0.45-0.60
SAIPAR:			
South Australian gas distribution[242]	Gas distribution	0.94-1.06	0.45-0.60

Australian ASX-listed asset betas, de-levered from adjusted equity betas, are in the range of 0.12 to 0.81. Australian regulatory decisions are in the narrower range of 0.35 to 0.60 and US utilities are in the lower range of 0.23 to 0.34.

Firms involved in the provision of infrastructure and utilities usually engage in long term projects and have high stability in their income and returns, but a high ratio of fixed costs. Further, the product supplied by such firms is generally regarded as being of an essential nature and therefore demand variations tend to be small as compared with changes in the general level of economic activity.[243] Such organisations would be expected to display equity betas less than 1. In Australia, there have been several new listings of infrastructure and utilities companies and regulators such as IPART, the ORG and the ACCC have all made decisions with respect to access arrangements in the gas and electricity distribution industries.

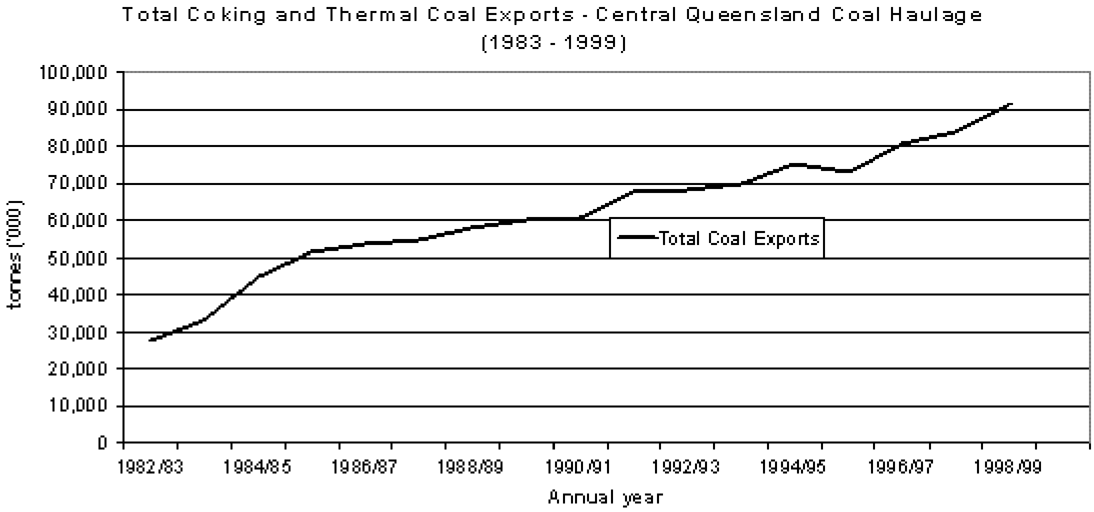
Analysis of QR's below rail cash flows

The cash flows of QR's below rail business were analysed by the QCA with respect to:

- variability in the railing of coal. Figure 6[244] shows the volume of coking and thermal coal exported from Central Queensland during the period from 1983 to 1999. It highlights substantial historical growth in coal exports at an average of 8.14% per annum since 1983 and having very low volatility;[245]

[235] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999
[236] Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000
[237] Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000
[238] Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000
[239] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000
[240] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000
[241] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998
[242] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000
[243] However, it should be noted that the motorways supplied by Hills Motorway group and Transurban City Link Limited are substitute services.
[244] Data is extracted from Central Queensland coal haulage export statistics provided by QR. These figures exclude West Moreton.
[245] The standard deviation of the annual growth rates has been only 4.12% since 1986.

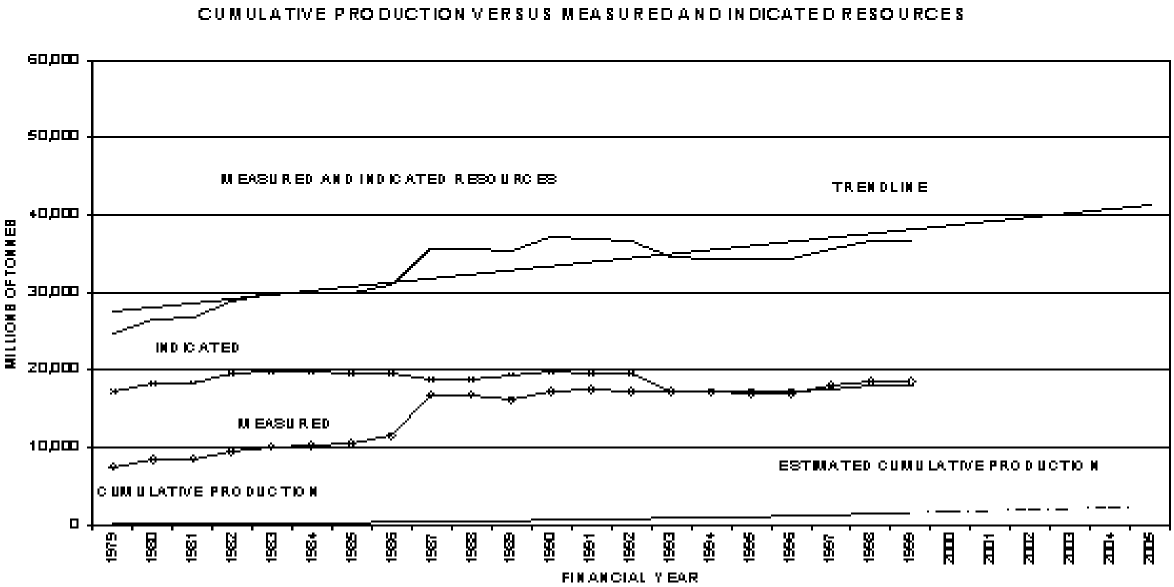
Figure 6



- the volume of coal available for mining (measured and indicated) substantially exceeds the cumulative coal production (see Figure 7). Further, the regulatory environment should insulate QR's below rail coal network from further volume risk. This is because a reduction in volume of 10% or more will trigger a review of the below-rail access charges for coal transportation allowing QR to increase access charges to restore its expected return on assets (refer to section 16.6). Given that access charges per tonne of coal are likely to constitute less than 5% of the value on average of a tonne of coal, it seems unlikely that QR's regulated return could be threatened by a downturn in the coal market;[246]

[246] Section 16.2 discusses the regulatory arrangements to apply to QR's reference tariffs. It is true that the asset beta for the provision of access to QR's coal network could be lower if QR was subject to a pure revenue cap (with an unders and overs account) rather than a price cap. This is because under a pure revenue cap, volume risk is effectively removed from the entity. A company's share price will fluctuate with changes in earnings expectations relative to the market as a whole. Under a pure revenue cap (accompanied by unders and overs arrangements), there is little reason for the expectations of the regulated entity's earnings to fluctuate significantly (although its net cash flows may be affected by changes in costs). However, in the case of QR's coal network, it would be difficult to attribute a difference (if any) in the asset beta between the two regulatory approaches as its volume is likely to be assessed as being low under either approach. Nonetheless, revenue caps could adversely affect QR's incentive to encourage additional traffic onto the network.

Figure 7



- analysis of the coal mines that QR serves suggest many are low cost producers by world standards. In 1998 for both thermal and coking coal, approximately two-thirds of Queensland mines operate in the lowest quartile of the world cost curve. In 1998, all Queensland coking coal mines except one operated below the world median[247] cost price. In the same year, only 6 thermal coal mines operated above the world median cost price;

- credit risk exposures for coal mining companies using QR's below-rail coal network are mitigated by guarantees from appropriate parties; [248]

- QR's below rail coal network faces relatively low exposure to domestic macroeconomic risks. Only about 10% of the volume of QR's coal net tonnage involves the transportation of domestic coal. Most of the domestic tonnage is sent to Queensland base load power stations. The 90% balance is exported to international users;

- the size and experience of the business. A well established and large enterprise such as QR will have less variable cash flows than a smaller firm in a competitive market. The level of competition is negligible and there are no substitutes for the QR below rail coal network. Also, QR's experience and use of well known technology limits the exposure to operating risks; and

- changes to the technology used in track operation have been slow and incremental. Basic track construction featuring rail, sleepers, ballast and formation has been largely unchanged for decades. Hence, there appears to be little risk of obsolescence or the need for technology substitution due to advances in technology. [249]

[247] The median is the 50th percentile of a distribution and thus represents the middle observation of all available data. In a normal distribution the median will equal the mean – however in skewed distributions this measure will take a different value.
[248] See Note 21 regarding Credit Risk Exposure in QR's Annual Report 1998-1999.
[249] The risk of technological obsolescence is more likely to be characterised as diversifiable risk.

Conclusions regarding QR's below rail asset and equity betas

For entities with no traded equity, such as QR's below rail coal network, it is necessary to use judgement in determining the appropriate asset and equity beta to be used in the estimation of the required return on equity funds.[250]

To calculate an equity beta for QR's below-rail coal network requires:

- the selection of an appropriate asset beta based on an analysis of comparable asset betas;
- analysis of factors affecting the stability of its cash flows; and
- an assessment of the most appropriate asset beta for QR's below-rail coal business which could then be re-levered to account for QR's below-rail coal network debt to equity ratio.

Comparable asset betas were estimated from adjusted equity betas and reported for domestic and international firms involved in rail, alternative forms of transport including domestic road transport, coal mining and entities in the infrastructure and utilities business. From the domestic market, listed firms and regulatory bodies suggest asset betas summarised in Table 21.

Table 21: Summary of domestic asset betas

Industry	Asset beta range (based on adjusted equity betas)	Median asset beta
Rail (regulatory decisions)	0.29-0.55[251]	n.a.
Alternative transport (listed companies)	0.24-0.72	0.59
Coal mining (listed companies)	0.39-0.84	0.51
Infrastructure and utilities (listed companies)	0.12-0.81[252]	0.48
Infrastructure and utilities (regulatory decisions)	0.35-0.55	n.a.

Although not directly comparable to Australian asset betas, it is noted that international asset betas are available for rail and for infrastructure and utilities and are summarised in Table 22.

[250] The associated increase in subjectivity which results does not lessen the fact that the cost of equity capital should still reflect the rate of return required by a shareholder.

[251] There are a number of methods of de-levering an equity beta to obtain an asset beta. The IPART equity betas, asset betas and gearing assumptions are not mutually consistent with the Brearley-Myers de-levering method used in the QCA analysis, implying the use of a different de-levering procedure. Hence, IPART's asset betas are not directly comparable with those derived here.

[252] Caution was exercised in interpreting this range as for Envestra (asset beta of 0.12), the equity beta was estimated using only 36 observations with a gearing of 0.7978 making this an outlier relative to other electricity and gas distributors which have a range of 0.1700 to 0.5148. If excluded the asset beta range becomes 0.45 to 0.58.

Table 22: Summary of international asset betas

Industry	Asset beta range (based on adjusted equity betas)
Rail (UK– listed)	0.53 – 0.80
Rail (US – listed)	0.44-0.59
Infrastructure and utilities (US)	0.23-0.34

The estimated asset betas across the broad range of comparable Australian industries suggest that the asset beta should be much less than that experienced by the Australian domestic road transportation industries as organisations in this sector are heavily exposed to domestic economic factors. Moreover, the Authority considers the asset beta of coal companies place a reasonable upper limit on the asset beta of QR's below rail coal network.

In particular, the Authority is of the view that the contractual arrangements, mine performance and cost competitiveness of Centennial Coal Company Ltd's operations make it the most representative of the coal companies at an asset beta of 0.42. However, it is reasonable to expect that QR's below-rail coal business would have a lower asset beta than Centennial due to QR's size and the fact that QR is exposed to considerably lower price and volume risk.

The lower end of the range should reflect the lower risk in listed infrastructure and utilities companies, although caution must be exercised here as several of the equity betas may be subject to measurement error. If considered independently of the cash flows, this would place the asset beta calculated with raw equity betas in a range from 0.35 to 0.45. This suggests an adjusted equity beta in the range of 0.53 to 0.76.[253]

In summary, QR's below rail coal network cash flows display a number of characteristics which suggest that the equity beta is well below 1. In particular these include:

- the very low level correlation between QR below-rail coal earnings and changes in the domestic economy;
- the nature of QR's contract and regulatory pricing arrangements;
- QR's limited volume risk; and
- the absence of any obvious negative impacts on QR's future cash flow.

These characteristics would suggest that QR's below-rail coal network has limited exposure to the domestic market and therefore would have returns which are not highly correlated with returns from holding the market portfolio – thereby reducing both the equity and asset betas to the lower end of the comparable industry ranges.

[253] Calculations were performed assuming a debt to equity ratio of 1.22 (Debt = 0.55, Equity = 0.45) and a debt beta of 0.20. the actual calculated adjusted equity beta range is 0.63 to 0.85. Caution must be exercised in the calculation of equity betas across a range of asset betas. As documented in F. Marston & S. Perry, (1996) 'Implied Penalty for Financial Leverage: Theory versus Empirical Evidence', *Quarterly Journal of Business and Economics*, vol. 35(2), pp. 77-97, the relationship between equity betas and financial leverage is non-linear with a higher penalty in the calculation of asset betas for those firms with high levels of leverage relative to firms with low leverage.

The QCA has also considered QR's initial submission of an asset beta for QR's Network Access Group[254] in the range of 0.5 to 0.6, the subsequently revised range of 0.45 to 0.55 and 0.45-0.50 as a range for the asset beta for the business relating to the provision of access to Network Access' coal network. Other stakeholder's submissions were also considered. However, when comparable industries are jointly considered with QR's below-rail coal network characteristics, the QCA considers the asset beta[255] to fall between a range of 0.35 to 0.45 and has estimated the asset beta at the upper end of this range (that is at 0.45).

Based on an asset beta of 0.45 the Authority has arrived at the adjusted equity beta for QR's below rail coal network at 0.76.[256]

4.6 Dividend imputation and rates of return

Introduction

Dividend imputation was introduced in Australia in July 1987. Dividend imputation is company tax, that is already paid by a company prior to the payment of dividends, that can be credited against any further personal tax liability of the shareholder if those dividends are 'franked'.

Under the imputation tax system, Australian resident taxpayers can claim a credit (imputation) against the income tax payable by them on dividends received from Australian resident companies, to the extent of the Australian income tax that has been paid by those companies in respect of that dividend income. The dividend is said to be 'franked' to the extent of the income tax that has been paid at the company level.

Under this system, a taxpayer can fully utilise the tax credits available. In other words, company tax is a pre-payment of personal tax for that shareholder. Hence, ignoring the timing impacts, an Australian resident taxpayer can be completely compensated for the incidence of company tax (but not personal tax). For foreign investors, Australian tax credits cannot be used to reduce tax payable in their own countries. Therefore, the after-tax return for a foreign investor receiving a franked dividend is lower than that for a domestic investor with an equivalent personal tax rate.

Gamma (?), typically expressed as a number between zero and one, represents the percentage of each dollar of dividends that is covered by an imputation credit. For instance, a gamma of 0.80 implies an imputation credit of $0.80 per dollar of dividend paid.

It is possible to record the impact of dividend imputation, either as an adjustment in the WACC calculation or as an adjustment to the cash flows of the business. The Authority's view is that it is appropriate to address dividend imputation in the same manner as any other cash flow item and therefore prefers to record the impact of dividend imputation in QR's cash flows. This will also help avoid any possibility of double counting of dividend imputation in both the cash flows and the WACC.

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[254] This asset beta range was arrived at after consideration of available data on QR other rail companies and other relevant organisations. It is noted however that the equity and asset betas for the Class 1 US railways used have fallen dramatically since June 1999.

[255] Based on adjusted equity betas.

[256] It should be noted that under the framework adopted by the Authority, the margin on the risk-free rate is primarily a function of the asset beta – the equity and debt betas will vary with the proposed capital structure such that their weighted average will equal the asset beta.

Empirical evidence on the valuation of imputation credits

The market value of franking credits is typically estimated by analysing ex-dividend share price movements. Company share prices can be considered as a bundle of expected future dividends and franking credits. The market's valuation of franking credits by shareholders may be determined by comparing the share price fall of companies paying franked dividends to the share price fall of companies paying unfranked dividends, on the day that the books close for dividend entitlements.

From the perspective of the marginal investor, application to QR of a gamma value of 0.5 would be consistent with eliminating resource misallocation by treating Government owned corporations in the same manner as private sector equivalents. However, in contrast, the Government, as shareholder of QR, could be regarded as having the benefit of full dividend imputation credits, subject to the timing difference between the date of paying tax and the date of dividend distribution (that is, gamma approaching 1).

Tables 23 and 24 outlines the available research and regulatory opinion on the issue of valuing the actual level of utilisation of imputation credits. Direct comparison between the results of these studies is difficult as they cover different time periods and different methodologies.

Table 23: Gamma – regulatory decisions

Regulatory Decision	Industry	Gamma (%)
ACCC:		
Epic Energy [257]	Gas distribution	50
Central West Pipelines [258]	Gas distribution	50
Snowy Mountains Hydro Transmission network[259]	Elec. transmission	0
NSW & ACT Transmission networks[260]	Elec. transmission	50
IPART:		
AGL Gas Networks[261]	Gas distribution	30 – 50
NSW Electricity Distribution networks[262]	Electricity distribution	30 – 50
Albury Gas Company [263]	Gas distribution	30 – 50
Electricity Networks & Retail Supply[264]	El. distribution/retail	30 – 50
NSW Rail[265]	Rail	30 – 50
Great Southern Energy [266]	Gas distribution	30 – 50
OffGAR:		
Parmelia Pipeline [267]	Gas transmission	50
Tubridgi Pipeline [268]	Gas transmission	50
Mid-west and South-West Pipeline[269]	Gas transmission	50
ORG:		
Victorian electricity distribution[270]	Electricity distribution	50
Victorian ports[271]	Ports	50
Victorian gas distribution[272]	Gas distribution	50
SAIPAR:		
South Australian gas distribution[273]	Gas distribution	50

[257] Australian Competition and Consumer Commission (2000) Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System, Draft Decision, 16 August 2000

[258] Australian Competition and Consumer Commission (2000) Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline, Final Decision, 30 June 2000

[259] Australian Competition and Consumer Commission (2000) Australian Snowy Mountains Hydro-Electric Authority Transmission Network Revenue Cap 1999/00-2003/04, Draft Decision, 6 June 2000

[260] Australian Competition and Consumer Commission (2000) NSW and ACT Transmission Network Revenue Caps 1999/00-2003/04, Final Decision, 25 January 2000

[261] Independent Pricing & Access Regulation Tribunal (2000) Access Arrangement for AGL Gas Networks Limited Natural Gas System in New South Wales, Final Report, July 2000

[262] Independent Pricing & Access Regulation Tribunal (1999) Regulation of New South Wales Electricity Distribution Networks, December 1999

[263] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Albury Gas Company Limited, Final Report, December 1999

[264] Independent Pricing & Access Regulation Tribunal (1999) Pricing for Electricity Networks and Retail Supply, June 1999

[265] Independent Pricing & Access Regulation Tribunal (1999) Aspects of the NSW Rail Access Regime, Final Report, April 1999

[266] Independent Pricing & Access Regulation Tribunal (1999) Access Arrangement for Great Southern Energy Gas Networks Pty Limited, Final Report, March 1999

[267] Office of Gas Access Regulation (2000) Access Arrangement Parmelia Pipeline, Final Decision, 20 October 2000

[268] Office of Gas Access Regulation (2000) Access Arrangement Tubridgi Pipeline, Draft Decision, 7 August 2000

[269] Office of Gas Access Regulation (2000) Access Arrangement Mid-west and South-west Gas Distribution Systems, Final Decision, 30 June 2000

[270] Office of the Regulator-General, Victoria, (2000) Electricity Distribution Price Determination 2001-05, Vol 1 Statement of Purpose and Reasons, September 2000

[271] Office of the Regulator-General, Victoria, (2000) Victorian Ports Price Review – Melbourne Port Corporation and Victorian Channels Authority, Final Decision, 13 June 2000

[272] Office of the Regulator-General, Victoria, (1998) Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd, Westar (Gas) Pty Ltd & Westar Assets Pty Ltd and Stratus (Gas) Pty Ltd & Stratus Networks (Assets) Pty Ltd, Final Decision, October 1998

[273] South Australian Independent Pricing & Access Regulator (2000) Access Arrangement for the South Australian Distribution Systems, Draft Decision, 13 April 2000

Table 24: Gamma – other studies

Study	Gamma (%)
Other studies:	
Cannavan, Finn & Gray (2000)[274]	0.48-0.76
Hathaway and Officer (1999)[275]	0.60
Bruckner, Dews and White (1994)[276]	0.48-0.88 (most likely value = 0.68)
Brown and Clarke (1993)[277]	0.72
WA Department of Transport (1999)[278]	0.30-0.50
ORG (1998)[279]	0.35-0.9 (preferred value = 0.5)

Estimation of QR's below-rail coal network gamma

Gamma is equivalent to the ability to access franking credits or the access rate (determined by the creation and distribution of imputation credits) multiplied by the utilisation rate determined by the redemption of the franking credits. Accordingly, the valuation of imputation credits is determined by the following three key events in the life of imputation credits which are discussed below:

- creation of imputation credits;
- distribution of imputation credits; and
- redemption or utilisation of imputation credits.

Creation of imputation credits - franked dividends are those dividends paid out of profits on which Australian corporate tax has been levied and hence carry a credit for income tax paid by the company. The return on a share with a franked dividend will be greater than the return on an equivalent share with a non-franked dividend. Dividends are able to be franked if the entity's income is earned in Australia and hence taxed at the corporate tax rate, and the income has been earned since the introduction of the imputation tax system on 1 July 1987.[280] It should also be noted that both dividends and franking credits can be issued from retained earnings and not just from the current year's free cash flows.[281]

[274] Cannavan, D., F.Finn and S. Gray (2000), 'The Value of Dividend Imputation Tax Credits', Unpublished Working Paper, Department of Commerce, The University of Queensland.
[275] Hathaway, N. and R. Officer (1999), 'The Value of Imputation Tax Credits', Finance Research Group, Melbourne School of Business. The study covers the period until 1995.
[276] Brucker, K., N. Dews and D. White (1994), *Capturing Value from Dividend Imputation*, McKinsey and Company, Sydney. This paper based the research on 88 of the Top 100 Australian companies over the six years to 1993. The paper found that imputation credits were valued between zero and 97% of face value; an average market valuation of a franking credit is between 48% and 88% of face value; and considered that 68% is a reasonable estimate.
[277] Brown and Clarke (1993), 'The Ex-Dividend Day Behaviour of Australian Share Price Before and After Imputation', unpublished manuscript, University of Western Australia.
[278] Macquarie Bank Limited, Independent Assessment of Maximum Rate of Return on Rail Infrastructure – Draft Report, 9 July 1999, commissioned by the Western Australian Department of Transport, p.16.
[279] Office of the Regulator General, Weighted Average Cost of Capital for Revenue Determination: Gas Distribution, Staff Paper No. 1, 28 May 1998, p. 52.
[280] The value of imputation credits is therefore dependent on the entity's effective tax rate. The lower the effective tax rate, the smaller the corporate tax payments and the smaller the advantage of dividend imputation.
[281] Thus there is no incentive to hold after tax free cash flow in retained earnings in perpetuity but also they can be retained over time without loss of availability.

Analysis of QR's below rail coal network after tax free cash flows shows that:

- all of QR's profits will be earned in Australia and are hence eligible to be franked; and
- QR's below-rail coal network is forecast to require modest capital expenditure over the next 10 years and thus it is anticipated that on a stand-alone basis, there will be few impediments to this part of QR's business having a high payout ratio.

Distribution of imputation credits - an entity's dividend policy affects the value of imputation credits. The smaller the payout ratio the less value imputation credits hold as the time value of imputation credits diminishes if a company defers payment of fully franked dividends. The introduction of dividend imputation in Australia has resulted in companies adopting generally higher payout ratios than during the pre-imputation period. Hathaway and Officer[282] found that 80% of company tax payments are distributed as imputation credits. The New Tax System (NTS) reverses some of the incentives for high dividend payout ratios that emerged from dividend imputation. This is because, under the NTS, capital gains attract a relatively low effective tax rate in a low inflation environment.[283]

One issue in the context of assessing the level of imputation credits is whether profits earned on the coal traffics, which are retained by QR for investment elsewhere in the network, should effectively be allowed to reduce the value of imputation credits (because of the deferral of payments) and hence increase QR's cost of capital. The Authority's view on this matter is that QR's cost of capital should not be substantially increased on account of major investments in the network not referable to its coal traffics. In other words, non-coal investments should not become a justification for effectively increasing the price of coal transport. Any other outcome would be inconsistent with the stand-alone cost approach that QR has proposed.

Redemption or utilisation of imputation credits - each shareholder attaches a different value to imputation credits depending on his or her tax status. The treatment of this issue is contingent on whether one adopts the position that the Queensland Government is the only shareholder or that the utilisation should reflect that of the marginal shareholder in the market. Each of these alternatives are discussed in turn.

In one view, QR and its shareholder, being the Queensland Government, are both exempt from Commonwealth tax (QR instead is subject to a state-based tax equivalent regime). Given that the State Government retains all of QR's tax payments, is it appropriate to assume the tax status of the Queensland Government as QR's only shareholder will enable it to fully utilise any imputation credits created. In this case, it could be assumed that the utilisation would equal 100%.

The alternative view is that the ability to utilise the franking credits should be contingent on the shareholder status of the marginal shareholder. As noted by Hathaway and Officer, 60% of the distributed franking credits are redeemed by taxable investors. The key issue is then the assumed shareholder status of the Queensland Government in the context of the assessed value of imputation credits. In this regard, the Authority considers that the most appropriate approach is to ignore any particular shareholder status emerging from QR being a GOC. This is because any other approach risks cost of capital induced resource allocation distortions towards the public sector.

[282] Hathaway, N., and Officer, R. (1999), 'The Value of Imputation Tax Credits', Finance Research Group, Melbourne School of Business. The study covers the period until 1995.

[283] The NTS may affect dividend pay-out ratios in several ways. For example, capital gains will not be indexed for the purposes of assessing capital gains tax under the NTS but they will be subject to tax at only 50% of the income tax rate. This means that there will be a tax advantage to shareholders receiving returns as capital gains (dividends) instead of dividends (capital gains) in times of low (high) inflation.

As part of the New Tax System, the Commonwealth Government passed legislation that has the effect of allowing the full offset of excess franking credits against income tax liability for Australian resident individuals and superannuation funds that previously were unable to claim the refunds.[284] Subject to the other effects from the NTS, this of itself would tend to increase utilisation levels relative to historical benchmarks.

Assessment - when estimating the value of imputation credits for the purpose of calculating QR's below rail coal network cost of capital, the QCA took the following factors into consideration:

- all of QR's profits will be earned in Australia and are hence eligible to be franked;
- on the basis of the QCA's cash flow modelling, QR's below-rail coal network will be in a position to maintain a high contribution towards QR's dividend payout ratio over the next 10 years. Consequently, it is expected that consistent with prior studies, 80% of QR's tax payments are distributed as imputation credits; and
- the range of utilisation will be between 60% and 100%.

Given that gamma is equivalent to the access rate (determined by the creation and distribution of imputation credits) multiplied by the utilisation rate this will give a range for gamma between 0.5 and 0.80. The Authority considers that the most appropriate approach to identifying gamma is to ignore any particular shareholder status emerging from QR being a GOC. This is because any other approach risks cost of capital induced resource allocation distortions towards the public sector. Accordingly, in the context of the marginal shareholder, the Authority has accepted QR's below rail coal network level of gamma at 0.50.[285]

4.7 Tax Rates

Alternative methods also exist to calculate WACC on either a pre-tax or post-tax basis. The appropriate WACC to use depends on the form of the cash flows being capitalised. The WACC can be derived on either a before (pre) or after (post) tax basis. Consequently, post (pre) tax cash flows should be discounted with post (pre) tax discount rates.[286] This reflects the fact that the formulation of QR's below-rail coal network WACC should be consistent with the definition of the cash flows used to calculate its revenue requirement. Each approach should be equal in perpetuity but can have significant differences when measured in discrete time.

Pre-tax WACC

An entity's cost of equity funds (as imputed using the CAPM) is usually expressed on a post-tax but before personal tax basis. There are broadly two alternatives to convert a post-tax WACC to a pre-tax WACC:

- transforming a post-tax WACC into a pre-tax WACC by grossing up the post-tax to account for the incidence of tax; or
- by calculating explicitly, for each year, a cost of tax based upon benchmark assumptions either explicitly in the cash flows or via a 'tax wedge' adjustment directly to the WACC.

[284] See Chapter 2 in New Business Tax System (Miscellaneous) Bill 1999 Explanatory Memorandum. House of Representatives, The Parliament of the Commonwealth of Australia. The law has effect from 1 July 2000. The net effect of the tax change will be to increase the return to low income earners and superannuation firms and will thereby increase the market value of a franking credit above current levels. However, overseas shareholders are still unable to use franking credits.

[285] This reflects gamma, calculated as 0.80 x 0.60 = 0.48 (approximately 0.50).

[286] Each of the approaches should be equal in perpetuity but can have significant differences when measured in discrete time.

Regardless of which method is selected it is necessary to establish which of the following tax rates should be applied:

- the statutory rate; or
- the effective rate.

QR's Undertaking refers to a pre-tax (that is, grossed up) WACC, but does not indicate the factor by which it proposes to gross up the post-tax WACC. At 30 June 2000, the statutory company tax rate was 36 percent. Following amendments in December 1999, the statutory tax rate for the 2000-01 tax year will be 34% and 30 % thereafter. In 1999 the Commonwealth Government legislation was passed which had the impact of removing accelerated depreciation[287] for plant acquired after 21 September 1999 and replacing accelerated depreciation with effective life depreciation.[288]

The effective tax rate adjusts the statutory rate for both timing and permanent differences of tax deductions and is recorded as the ratio of the tax expense to the accounting operating profit before tax.[289] The owner of infrastructure assets with a long life may claim a tax deduction for depreciation during the assets' economic life, thus bringing forward the tax deductions and increasing the value of these tax benefits in net present value terms. Thus, allowing for the time value of money, the effective tax rate for a major infrastructure provider may be below the statutory rate.[290]

The use of a pre-tax rate of return is often advocated on the grounds that it avoids the need to explicitly add into the 'cost of service' calculation an amount to compensate for tax obligations of the regulated business. However, the tax calculation still needs to be undertaken to convert from the post-tax rate of return, indicated by CAPM benchmarks, to the corresponding pre-tax rate, required for the regulatory framework. Therefore both approaches require tax liabilities to be properly assessed and there is little difference between a post-tax and pre-tax formulation of WACC in perpetuity. As noted by the ACCC:[291]

> "Given there is little to choose between post-tax and pre-tax formulations, the issue is fundamentally how best to assess tax liabilities – short or long term.
>
> There are a number of flaws associated with the use of a long term pre-tax WACC including:
>
> - front end loaded investor returns;[292]

[287] Accelerated depreciation (AD) refers to the situation where the cost of an asset is depreciated over a shorter period than the asset's effective life. It is achieved through the allowance of deductions for declines in the value of an asset at higher rates than are expected to occur in practice. This has the impact of providing the taxpayer with a cash flow advantage. AD has the impact of bringing forward depreciation deductions resulting in tax being deferred during the early years of an assets useful life and increases tax in later years. AD provided significant benefits to capital intensive industries such as mining and manufacturing, whilst being of little benefit to service industries such as finance, tourism or retailing.

[288] Effective life depreciation involves the depreciation of the wasting asset over the effective life of the asset. A wasting asset can be defined as those assets, which at the time they are acquired or created, can be reasonably expected to decline in value over time.

[289] In practice, if a relatively high value of imputation credits (gamma) is adopted, then the issue of the tax rate (whether statutory or effective) assumes considerably less significance.

[290] The approach supported by most academics and practitioners is the use of the effective tax rate. Hathaway and Officer (1995) found that the effective company tax rate in Australia was much closer to 19% than the statutory rate of 36%. This is supported by modelling work undertaken by Macquarie Risk Advisory Services (1998), which suggests that the effective tax rate over a fifty year period is likely to be around 20%. The effective tax rate reported by QR in its 1998-1999 Annual report equalled 37.92% in 1999 and 38.51% in 1998. The RAC's effective tax rate was zero in both years whilst the Westrail's was 18.02% in 1999 and in 1998 equal to 60.23%.

[291] ACCC, Draft Statement of Principles for the Regulation of Transmission Revenues: Supplementary Papers, (27 May 1999) p. iii.

[292] Actual tax payments tend to be concentrated towards the end of the life of the assets. This arises because tax depreciation provisions (especially in the presence of accelerated depreciation) historically have allowed capital expenditures to be written

- uncertainty over long term tax provisions; and
- difficulties in estimating long term effective tax rates and applying them within a formula-based approach."

However, it is very difficult to estimate the effective tax rate over the life of assets which span from 25 to 100 years. This is because such estimates are dependent on assumptions in respect of the maintenance of the effective tax regime, inflation and the depreciable value of assets for tax purposes. Altering access prices for changes in effective tax rates may result in an undesirable increase in price volatility. Therefore there are advocates of the use of the statutory tax rate rather than the lower effective tax rate.[293]

An alternative approach to the treatment of QR's tax liabilities is to use a post-tax WACC for the determination of the revenue requirement by including QR's forecast tax payments in the cash flows. Under this approach, tax payments would be based on a 10-year financial model developed by the Authority based on information provided by QR.

Post-tax WACC

This approach treats tax liability in the same manner as any other cash flow item. Explicitly addressing tax expense through cash flows ensures that users only pay for the tax expense actually incurred by QR in the provision of its below-rail services. It will also remove much of the ambiguity, uncertainty and error by keeping taxation issues out of the definition of the WACC and is also consistent with the underlying CAPM approach adopted (for example, the determination of the return on equity and the treatment of imputation credits).

In discrete time, different formulations of WACC can affect arguments in favour of a post-tax WACC including that:

- the CAPM produces a post-tax nominal return on equity and WACC. The conversion of this to a pre-tax equivalent is complex and varies with regard to the techniques available for pre-corporate tax or pre-corporate and personal taxes;
- corporate taxes are a cost to the company like any other cost, and post-tax measures of return are more relevant to investors. Adopting a post-tax WACC requires cash flow modelling to explicitly address the question of the cash flow implications of taxation liabilities and an organisation's financial position. Accordingly, this approach is the most transparent and rigorous;
- the concept of pre-tax is not a common one and there is potential for misunderstanding. There is difficulty in estimating a long term effective tax rate as the tax system is not static. This may result in a perception that there may be a risk that adjustments would not adequately compensate for any changes in the tax system or errors could be introduced which result in under compensation in the rate of return; and
- the conversion from post-tax to pre-tax WACC should be 'neutral' in that it is important to maintain consistency between the WACC used and the underlying cash flows – particularly in respect of corporate taxation and dividend imputation. Otherwise there is risk of significant distortions being introduced.

off faster than the economic rate of depreciation. As a result businesses obtain returns well in excess of those intended under the regulatory framework in the early years but these are offset by lower than commercial returns later on.

[293] Australian Competition and Consumer Commission, NSW and ACT Transmission Network Revenue Caps: Decision, January 2000, p. 41.

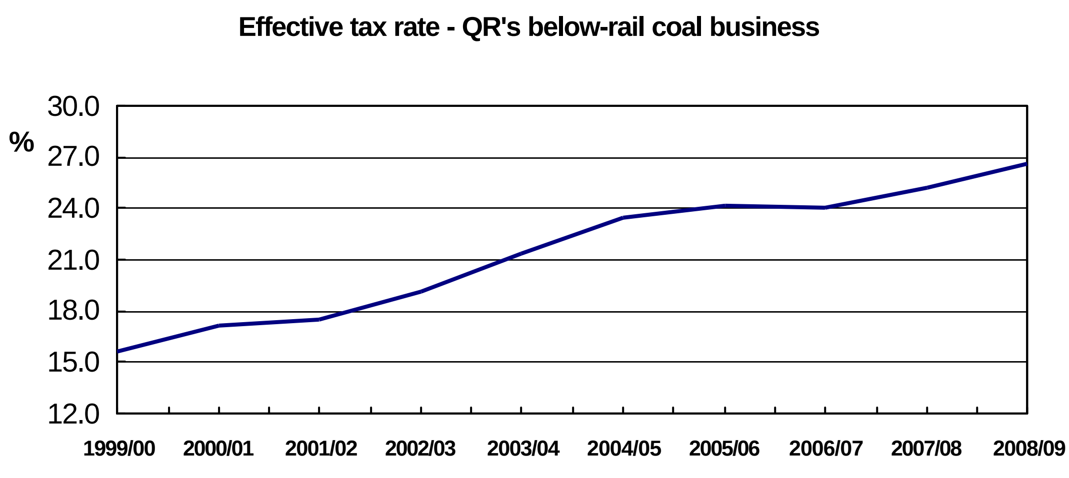
The key point is that for there to be no difference between pre and post-tax formulations, tax cash flows must be explicitly incorporated as part of the modelling process. Accordingly, it would appear that the most appropriate way to address the treatment of tax is to adopt a relatively simple WACC formulation and to deal with tax liabilities and imputation credits in the cash flows.

Nevertheless, Australian regulators have not reached a consensus on this issue. Supporters of the pre-tax WACC formulation argue that it is consistent with inter-generational equity. This is because customers of the network at different points in time will pay different charges for the same set of assets as a result of the assets' changing tax position rather than the underlying value of the service being provided. This is particularly the case where the firm takes advantage of tax concessions in the early years of the life of an asset, with tax liabilities increasing over time (the so-called 'S-bend debate').

These arguments overlook the fact that accelerated depreciation arrangements generate favourable cash flows for the regulated entity. Ignoring these cash flows will create a windfall benefit for the regulated entity. In any event, the Authority's 10-year modelling horizon, for an organisation that has a portfolio of assets with differing ages, substantially alleviates these concerns. In practice, other factors, such as the growth in the use of the network, could normally be expected to dominate the tax timing issue in terms of pricing impacts.

Figure 8 illustrates the effective tax rate that this approach produces, based on QR's forecast below-rail coal profit in each year of the modelling horizon. The steady rise over the period reflects the decreasing influence of accelerated depreciation in reducing QR's effective tax rate, relative to the statutory tax rate.

Figure 8



Accordingly, the Authority has adopted a post-tax cost of capital. In other words, the prevailing statutory tax rate (which equates to 34% in the 2000-01 tax year and 30 percent thereafter) has been applied to QR's forecast taxable income in order to estimate QR's tax liabilities. Adopting this approach means that issues such as quantifying the 'tax wedge' are no longer relevant. It is also consistent with the assumptions underlying the CAPM.

In assessing QR's actual tax liability the Authority considered how tax expense related to QR's coal traffics should be treated in the context of the remainder of QR's below rail business. In this regard, the Authority notes the desirability of adopting a consistent approach with related issues (including the determination of the return on equity and the treatment of imputation credits).

This approach addresses taxation liability in the same manner as any other cash flow item (and instead relies on a post-tax WACC for the rate of return). This is because the Authority is mindful that explicitly addressing tax expense through the cash flows ensures that users only pay for the tax expense actually incurred by QR in the provision of its below rail services. This will remove a lot of the ambiguity, uncertainty and error by keeping taxation issues out of the definition of the WACC and is also consistent with the underlying CAPM approach adopted.

Similarly, it is possible to record the impact of dividend imputation either as an adjustment in the WACC calculation or as an adjustment to the cash flows of the business. The Authority's view is that it is appropriate to address dividend imputation in the same manner as any other cash flow item and therefore prefers to record the impact of dividend imputation in QR's cash flows. This will also help avoid any possibility of double counting of dividend imputation in both the cash flows and in the WACC.

4.8 Nominal or real WACC

Just as the WACC can be derived on either a pre) or post-tax basis, it may also be estimated on a nominal or real basis. Consequently, nominal (real) cash flows should be discounted with nominal (real) discount rates.[294]

The nominal and real rates of return WACCs are equivalent provided consistency is maintained with inflation adjustments, depreciation allowances and debt figures. The QCA financial model has been developed based on a nominal rather than a real basis for the following reasons:

- depreciation in a nominal framework is transparent and there is no potential for confusion over the extent of recovery. However, this is not the case for a real framework as depreciation allowances include adjustments for inflation so that accumulated depreciation may exceed the actual cost of the asset unless depreciation amounts are deflated;

- similarly, interest expense and other non-inflationary cash flows, such as capped revenues or revenues from contracts containing no CPI adjustments, require particular caution when converting from a nominal to real basis. Errors in the conversion will result in discrepancies in the underlying cash flows;

- tax and balance sheet items such as debt and equity are all expressed in nominal terms. Consequently, the stock of debt must be deflated if modelling is to be undertaken in real terms;

- a nominal WACC is directly comparable with other financial benchmarks such as the nominal rate of return of other investments;[295] and

- the nominal approach is the preferred approach of academics[296] and practitioners.[297]

Again, whilst it is possible to achieve identical results in a real or nominal environment, the Authority prefers to adopt a nominal WACC to minimise the risk of modelling error. Further, it should also recognised that use of a CPI-X regulatory environment also minimises inflation risk.

[294] Each of the approaches should be equal in perpetuity but can have significant differences when measured in discrete time.
[295] This is likely to avoid any confusion with financial markets and other interested parties as they may not understand the economic relationship between real and nominal as well as pre and post-tax rate of return.
[296] ACCC and ORG (1998), 'Public Forum on the Weighted Average Cost of Capital (WACC) in the Victorian Gas Access Arrangements', 3 June; Davis, K. (2000), 'Asset Valuation and the Post-Tax Rate of Return Approach to Regulatory Pricing Models', paper presented at the ACCC Asset Valuation Forum, Melbourne, 16 June 2000.
[297] ACCC and ORG (1998), 'Public Forum on the Weighted Average Cost of Capital (WACC) in the Victorian Gas Access Arrangements', 3 June, p.18. Michael Lawriwsky from Banker's Trust critiqued the use of pre-tax real rates of return and stated "…the market is not used to dealing in pre-tax real WACCs."

Estimation of inflation

The level of expected inflation is not an explicit parameter in the calculation of WACC. However, it is relevant to the financial modelling exercise. During periods of inflation, there is a fall in the purchasing power of money.

Four primary methods exist for the estimation of expected inflation:

- survey based methods where market participants are surveyed to assess their expectations of expected inflation;
- statistical based methods using regression or time series models;
- models based on the Fisher model[298] which suggests that there is a systematic relationship between nominal interest rates and the expected rate of inflation. Here the level of expected inflation is implied from the yields on nominal and Commonwealth Treasury capital indexed bonds (CIB); and
- the use of secondary sources including monetary and fiscal policy documents. For example, the RBA medium term inflation target is 2 to 3%. Similarly, in forecasting future revenues State and Commonwealth governments report anticipated CPI as part of their fiscal policy budget.

The Authority's preferred approach is to measure inflation using the Fisher approach as the difference between the nominal bond rate and inflation-indexed bonds over the same period. The benefit of such an approach is that it delivers a forward looking estimate of inflation rather than an historic measure.

Consistent with the view that information should be as up-to-date as possible, the Authority has calculated an expected inflation rate based on the difference between the 10-year bond rate and a similar duration indexed bond rate based on the rate of the day of the decision. Caution should be exercised in using the Fisher equation as:

- bonds must be matched as closely as possible by both maturity and coupon; and
- the equation must account for the compounding frequency of the coupons.

On 20 November the 10-year Commonwealth Government bond yield was 5.92%. The yield on a CIB of similar maturity was at 3.295% which implies an inflation rate of 2.54%. The level of expected inflation estimated using this approach has been under 3.00% since 1998, except for a brief period in the first quarter of 2000.

A study by Macquarie Bank Risk Advisory Services Limited[299] reported that anecdotal evidence suggests that the premium at which nominal bonds trade may incorporate a small risk premium for inflationary uncertainty as well as inflationary expectations. This suggests that 'true' inflationary expectations may be less than the nominal/CIB spread. Therefore, the Authority has set the expected inflation to 2.50% for use in determination of the real rate of return.

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[298] Fisher, I. (1907), *The Rate of Interest: Its Nature, Determination and Relation to Economic Phenomena*, Macmillan, New York. See also Fisher, I. (1930), *The Theory of Interest*, Macmillan, New York.

[299] Macquarie Risk Advisory Services Limited (1998), Weighted Average Cost of Capital: Further Issues, a report commissioned by the Victorian Office of the Regulator General.

5. DERIVING THE RATE OF RETURN

One of the most significant issues to be addressed in any process to set maximum prices involves the determination of the entity's allowed rate of return which is normally based on the weighted average cost of capital. The WACC may be characterised in a number of ways to reflect the capitalisation of the cash flows. However, it is critical that the cash flows be defined consistently with the assumptions underlying the particular characterisation of WACC adopted. Inconsistency between the measured cash flow and the approach to measuring the WACC will result in errors in the valuation process.

5.1 Alternative approaches to estimating WACC

When expressing WACC in post-tax nominal terms in the presence of dividend imputation, there are several alternative specifications available which the Authority will refer to as WACC 1 to WACC 4.[300]

Under WACC 1, cash flows are presented as the standard after-tax definition of cash flows under a classical system. This results in an overstatement of tax and imputation and the tax shield for debt are ignored. The WACC must fully account for the imputation effects.

Under WACC 2, all operating income is taxed at the company tax rate, adjusted for imputation. However, tax is still overstated in the cash flows as the tax shield for debt is ignored. The WACC must correct for the overstated tax shield.

Under WACC 3, the effective after corporate tax income attributable to equity and debt holders is fully and correctly recognised in the cash flows. The net impact of this approach is that it keeps all tax adjustments out of the WACC and recognises them directly in the cash flows.

Under WACC 4, imputation is fully and correctly recognised as a modified cash flow but tax is overstated as the debt shield is ignored. The WACC must correct for the overstated tax effect.

Each of the measures involves different specifications of WACC and an accompanying adjustment to the cash flows being analysed. These methods are discussed in detail by Officer[301] who demonstrates that, when applied correctly, they all result in the same value for the entity. In other words, WACC 1 to WACC 4 will result in the same discounted value of the entity provided each uses the correct specification for cash flows in perpetuity.

To achieve parsimony in model selection it is preferred by the Authority that all the effects of imputation be recognised in the cash flows as opposed to mixing between the cash flows and the WACC. Provided cash flows are expressed as the levered cash flow available to service debt and equity, after allowing for the tax deductibility of interest and the value of any imputation tax credits, the Authority therefore endorses the use of WACC 3 to calculate the after-tax WACC of QR's below rail coal network.

5.2 Estimation of WACC

A summary of the parameters selected by QCA as appropriate for QR are detailed in Table 25. The nominal post-tax WACC for QR's below-rail coal network has been estimated to be 8.63% which represents a margin of 2.71% over the risk-free rate.

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300 Alternative methods to calculate WACC and associated issues are discussed in Appendix F.

301 Officer, R.R. (1994) 'The Cost of Capital under an Imputation Tax System', *Accounting and Finance,* vol. 34(1), pp. 1-18.

Table 25: Summary of parameters and WACC estimates for the Draft Decision

Parameter	QCA estimates
Nominal risk-free rate (%)	5.92[302]
Market risk premium (%)	6.00
Equity beta	0.76
Asset beta	0.45
Debt beta	0.20
Debt/value (%)	55
Franking credit (gamma) (%)	50
Debt margin (%)	1.20
Cost of debt (%)	7.12
Tax rate (%)	30[303]
Nominal post-tax cost of equity (%)	10.48
Nominal pre-tax cost of equity (%)	12.33
Nominal post-tax WACC (%)[304]	**8.63**
Nominal pre-tax WACC (%)	9.46

[302] Rate as at 20 November, 2000. The rate to apply as part of the Final Decision will be foreshadowed to interested parties before the decision is released

[303] The statutory tax rate is set at 34% in the 2000-01 tax year and 30 percent thereafter. The nominal pre-tax cost of equity and pre-tax WACC will use the effective tax rate that has been estimated from QR's below rail network forecast cash flows.

[304] Alternative measures of post-tax nominal WACC would have produced the following results using data from working paper 5:

WACC	WACC
$WACC\ 1 = r_e \frac{(1-T_c)}{(1-T_c(1-g))} \frac{E}{(E+D)} + r_d(1-T_c)\frac{D}{(E+D)}$	6.62%
$WACC\ 2 = r_e \frac{E}{(E+D)} + r_d(1-T_c(1-g))\frac{D}{(E+D)}$	8.04%
$WACC\ 4 = r_e \frac{E}{(E+D)} + r_d(1-T_c)\frac{D}{(E+D)}$	7.46%

APPENDIX A Queensland coal industry

Black coal is Australia's largest export industry, worth $9.3 billion in 1998-99, equivalent to approximately 11% of Australia's total export value. Exports from Queensland contributed $5.4 billion or 25.3% of State export revenue in 1998-99, equivalent to 5.6% of State GSP. Given the recent economic slowdown in Asia, coal prices in Australian dollar terms have fallen slightly with thermal and coking coal selling at prices of AUD$42.00/tonne and AUD$62.00/tonne respectively towards the end of June 2000.

Most of Australia's black coal supplies are located in Queensland and NSW. The Queensland Department of Mines and Energy has estimated the existence of 37 billion tonnes (Bt) of raw coal in situ in 10 basins in the State. Of the total Queensland coal resources, around 23.5 Bt are primarily suitable for utilisation as thermal (power stations) and pulverised coal injection[305] coals and just over 13 Bt primarily suited to metallurgical coking coals (steel production).

Thirty-five of the 43 mines operating in Queensland during 1998-99 were located in the Bowen Basin. The remainder were located in the Surat, Callide, Tarong, Moreton-Ipswich and Maryborough Basins. The majority of export quality coal is mined in the Bowen Basin, which contains reserves of around 26 Bt of coking and thermal coal. The Surat and Moreton Basins located in South-east Queensland contain around 5.8 Bt of primarily thermal coal. Coal is mined for domestic use in the Callide, Tarong and Maryborough Basins.

Coking coal accounts for approximately 51% (57 Mt) and thermal coal around 49% (55.7 Mt) of annual Queensland production.[306] Between 1990-91 and 1998-99 coking and thermal coal production have grown at average annual rates of 3.2 and 6.6 per cent respectively.

The major portion of coal produced in Queensland is sold in overseas markets while domestic sales are concentrated in the electricity generation and metal processing sectors.

Chart 1: Total coal sales

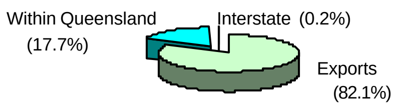
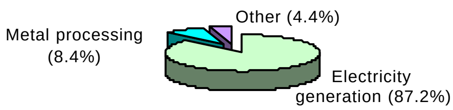


Chart 2: Domestic sales

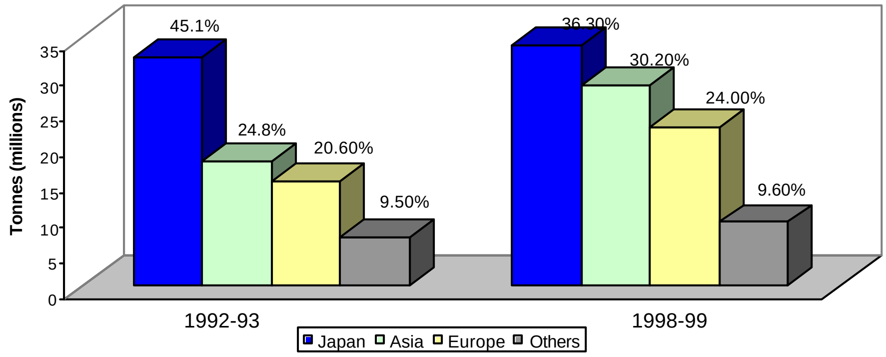


The pattern of Queensland's export coal sales has changed over the course of the 1990s. There has been a reduction in the dependence on Japanese importers as new markets have emerged in Europe, East Asia and on the subcontinent. Chart 3, which illustrates sales to major overseas markets in 1992-93 compared to 1998-99 by volume and proportion of sales, reflects this development. However, much of the future growth is expected to come from Japan and Asia.

[305] Pulverised coal injection (PCI) coals are weak coking or thermal coals. Under the PCI technique for steel production, the quantity of coking coal in the blast furnace is reduced and replaced with PCI coals.

[306] A small portion of total Queensland coal production is not railed. This output is primarily used for power generation at Tarong, Callide (delivered by conveyor belt from the mine) & Swanbank (around 80% of delivery by truck) power stations, and also constitutes stockpiles at mines.

CHART 3 QUEENSLAND'S MAJOR COAL EXPORT MARKETS



Throughout the 1990s, industry earnings have risen as a result of output growth (around 4.5 per cent per annum) offsetting real price reductions (around 2.5 per cent per annum). Queensland accounts for approximately two thirds of Australia's coking coal exports and one third of thermal coal exports. NSW exports the balance.

APPENDIX B Using moving averages to approximate the risk-free rate

The QCA undertook an analysis of the 10-year Commonwealth Government bond rate relative to 5, 10, 20 and 40-day moving averages.[307] Figure 9 plots the 10-year Commonwealth Government bond rate, the 5-day average and the 10-day average rate from January 1996 to December 1999. Figure 10 plots the 10-year Commonwealth Government bond rate and the 20 and 40-day moving averages over the same period. These figures highlight that the use of the moving average measures results in a lag following turning points in the spot market series due to the averaging process with the 40-day rate slower to react than the other averages.

Descriptive statistics are shown in Table 26. The 20 and 40-day moving averages have lower means and are less volatile than the underlying 10-year bond spot rate and shorter moving averages. The minimum and maximum figures found for all of the moving average processes lie within the range of the minimum and maximum rates for the 10-year spot rate. As a result it is concluded that averaged data is incorporated within the range of the spot market data and consequently adds little additional information to the process.

Table 26: Descriptive statistics of risk-free rate candidates[308]

	10-year bond rate (%)	5-day moving average (%)	10-day moving average (%)	20-day moving average (%)	40-day moving average (%)
Mean	6.67	6.67	6.62	6.66	6.64
Standard Deviation	1.1448	1.1433	1.1420	1.1391	1.1338
Minimum	4.72	4.77	4.78	4.84	4.97
Maximum	9.13	9.01	8.99	8.93	8.90

[307] The QCA also investigated several alternative smoothing methods including a centred 20-day moving average, a simple exponential smoothing filter (EXP), the Holt Winter – no seasonal filter (HW), and the Hoderick and Prescott filter (HP). However, each of the above models has serious limitations for use in the identification of an appropriate risk-free rate. For example, the centred MA (20) assumes perfect foresight of the next 10 observations to identify the current value and the EXP, HW and HP parameters are fitted using a least squares algorithm and therefore coefficients are sensitive to the inputted data. When considered relative to the 20-day MA, the Centred MA (20), EXP, HW and HP offer very little in additional efficiency in forecasting actual bond rates. The 20 and 40-day MAs offers more transparency in their calculation than these alternatives as each approach is easily understood by interested parties.

[308] Correlation analysis revealed that each of the moving average series appeared to be significantly correlated with the spot market series. To examine whether there was a difference in the each of the series on a daily basis, a matched t tests were used to assess whether each of the series were significantly different. These tests revealed that the 5 and 10-day moving average series were not significantly different from the spot rates but the 20 and 40-day moving averages were significantly different from the spot rates.

Figure 9

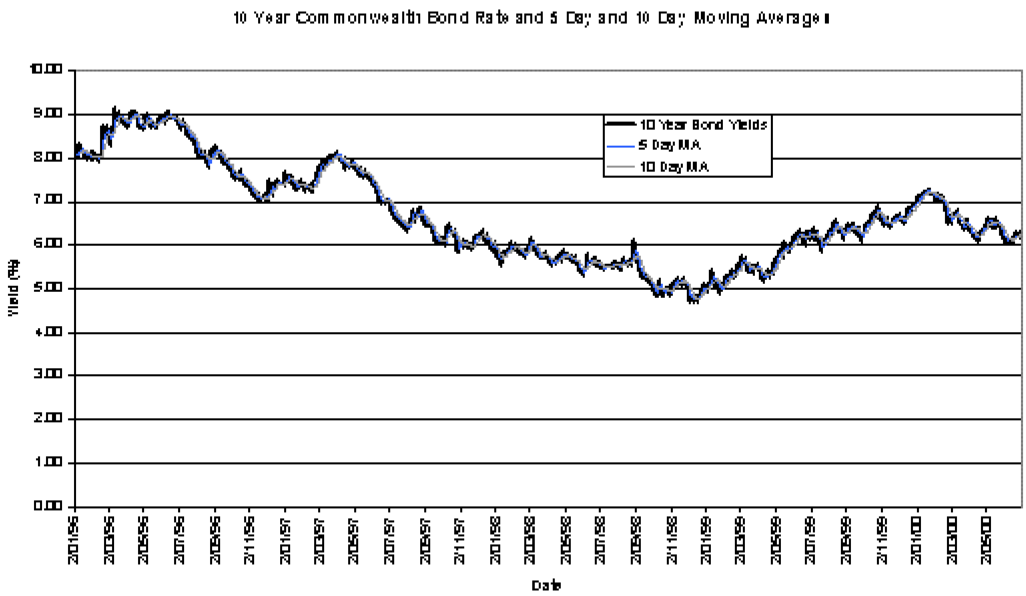
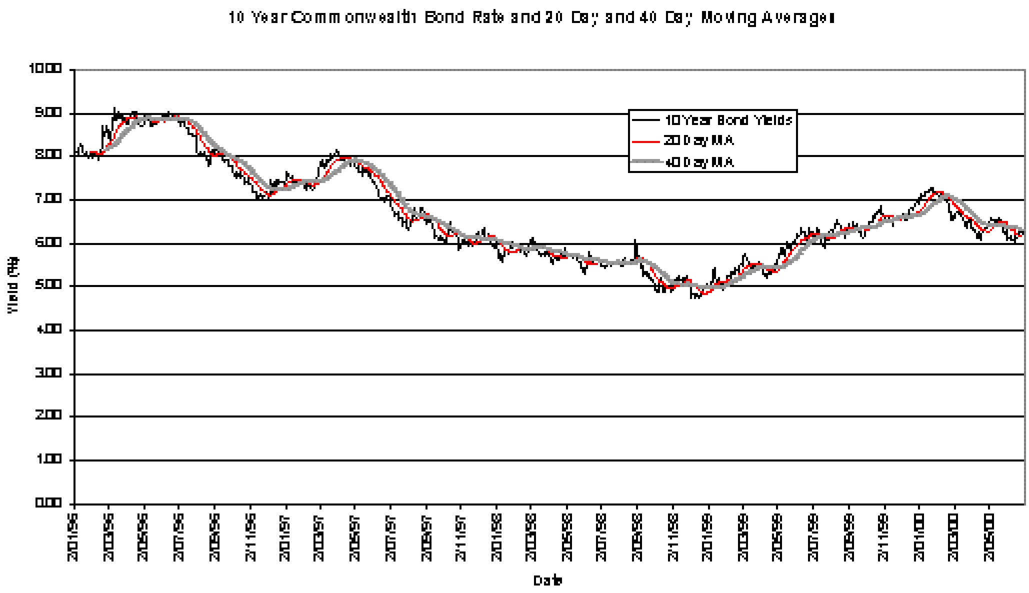


Figure 10



APPENDIX C The impact of dividend imputation on the market risk premium

To accommodate dividend imputation,[309] the definition of risk premium in the CAPM requires an adjustment to include the capitalised value of personal tax credits to maintain consistency between the cost of capital and cash flows which are defined on an after company tax but before personal tax basis. This is because, under an imputation tax system, credit is given to shareholders for the company tax implicitly levied on their dividend receipts at the company level. Therefore, the tax collected at the company level may be considered as a mixture of personal tax and company tax.

There is no conclusive empirical evidence to support the argument that dividend imputation has had a systematic effect on the market risk premium in recent years. However, there has been persistent anecdotal comment to the effect that Australian resident investors prize franked dividends and that share prices are clearly higher where franked dividends are expected.

The Authority examined the market risk premium in the period from 1970 to 1998 in detail to assess whether there was any significant difference in the market risk premium from the pre to post-imputation periods. Figure 11 suggests that there does appear to have been a sustained decline in the Australian equity market risk premium following 1987 to levels consistent with the 1970's. The QCA found that there does appear to have been a sustained decline in the Australian equity risk premium from historical levels in the period from 1987 to 1998 relative to the 1980's. However, this cannot be solely attributed to dividend imputation. Other possible issues that need to be considered include:

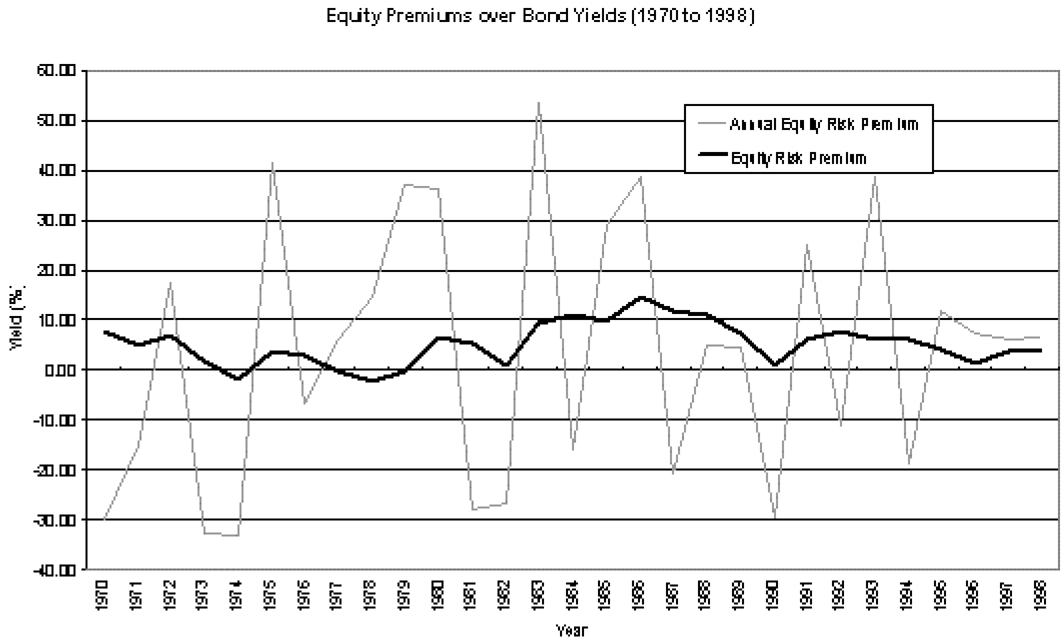
- the decline in the risk-free rate to its lowest levels since the late 1960's and the sustained decline in the level of inflation during the 1990's leading to decreased equity risk premiums;
- an increased used of financial leverage to engage in equity market transactions;[310]
- changes in patterns of share ownership with increasing numbers of private shareholders following the recent floats by Telstra and AMP;
- increased influence of institutional investors on long term investment horizons thereby decreasing equity risk premiums[311];
- improved communications and technology and corporate disclosure requirements have decreased information risks as information is now disseminated very quickly; and
- significant reductions in the level of corporate tax levels.

[309] Dividend imputation was introduced in Australia in July 1987. Under the imputation tax system, dividends paid on or after 1 July 1987 by Australian resident companies have been franked with an imputation credit to the extent that Australian income tax has been paid by the company. The imputation system allocates or imputes taxable income paid at the company level to resident individual shareholders. As such the taxable income of a resident shareholder is grossed up by an amount equivalent to the company tax previously paid. For foreign investors, Australian tax credits cannot be used to reduce tax payable in their own countries. Hence the after tax return for a foreign investor receiving a franked dividend is lower than that for a domestic investor with an equivalent personal tax rate.

[310] There have been changes in the demography of the Australian workforce with a greater proportion of relatively young savers in the Australian working population. The proportion of 35-54 year old workers has risen from approximately 36.5 percent of the working population in 1987 to 42 percent in 1996 whereas the 55–64 year old workers have declined from almost 14 percent to under 13 percent over the same period. This demographic shift is expected to generate an increase in demand for equities relative to bonds leading to downward pressure on the equity risk premium.

[311] A study of Australian retirement and life insurance companies by Edey and Simon (1996) found significant growth in funds under management and reallocation from bonds to equity over the past three decades. See Edey, M. & J. Simon

Figure 11



Regarding the impact of dividend imputation, it is possible to identify three positions in the academic literature regarding the debate.

No impact argument

This is a polar position that asserts that the equity premium, as conventionally measured, will be unchanged by the introduction of imputation. This argument suggests that in a small open economy like Australia, equilibrium rates of return are likely to be determined by capital flows from international as opposed to domestic investors. If so, domestic tax changes are likely to have no effect at all on equilibrium rates of return. This is because even though Australian equity returns will carry imputation credits, these will not be priced nor be of any use to international investors.

Partial fall argument

This mid-ground argument asserts that, in the presence of partially grossed up returns, the equity premium is unlikely to have changed since this will leave relative returns after tax unchanged. Hence conventionally measured returns must have fallen with the introduction of imputation as they do not include the adjustment for the utilised franking credits in their calculation.

(1996), 'Australia's Retirement Income System: Implications for Saving and Capital Markets', Reserve Bank of Australia Discussion Paper No 9603, September.

This view is discussed in Officer[312] who notes that, when estimates of returns are derived under an imputation tax using the conventional formula, then some personal tax will be capitalised into the risk premium which will consequently be lower. In these circumstances it will be necessary to make an adjustment to the conventional formula to reflect the after company tax but before personal tax return.[313] Using the partially grossed up formula and the conventional formula, Officer, shows that:

$$r^{pg} = \frac{[d + gC + \Delta P]}{P_{t-1}}$$

$$r^{pg} = \frac{[d + \Delta P]}{P_{t-1}} + \frac{[gC]}{P_{t-1}}$$

$$r^{pg} = \frac{[d + \Delta P]}{P_{t-1}} + t$$

where

r^{pg} is the partially grossed up return

τ is the value of tax credits expressed as a rate or proportion of the initial value of the share

d is the dividend per share (franked, partially franked or unfranked)

DP is the change in price

gC is the value of personal tax credits multiplied by the amount of tax credits per share distributed at time t

Full fall argument

This alternative polar argument, advocated by Monkhouse,[314] asserts that the equity premium in Australia will be lower than pre-imputation (or for the current offshore investor) by the extent that the imputation credits available to domestic investors. Monkhouse (1993, page 14, footnote 23) argues that:

> "the introduction of the dividend imputation has, however, ensured that market participants have obtained additional returns via the flow of imputation credits, either by dividend distributions, or by (additional) capital gain because of the expectation of the distribution of imputation credits at some later date."

the total market return is represented by:[315]

[312] See Officer, R.R. (1988) 'A Note on the Cost of Capital and Investment Evaluation for Companies Under the Imputation Tax', *Accounting and Finance*, vol. 28(2), pp. 65-71 and Officer, R.R. (1994) 'The Cost of Capital under an Imputation Tax System', *Accounting and Finance*, vol. 34(1), pp. 1-18.

[313] Officer (1994, p10) argues that if the imputation tax does not affect the cost of capital on an after company tax basis, then the rate of return on an individual company should be estimated using historical rates estimated under the classical tax system.

[314] Monkhouse, P.H.L., (1993) 'The Cost of Equity Under the Australian Dividend Imputation Tax System', *Accounting and Finance*, vol. 33(2), pp. 1-18.

[315] Monkhouse (1993, p. 5) assumes "for all entity's in the market, each dollar of imputation credits retained by an entity will increase that entity's equity value by a constant amount." This allows for the possibility that the market will place a positive value on (undistributed) franking account balances.

$$R_m = r_m + q_m^d D_m^{'} t_{mf} + q_m^r RIC^{'}$$

where

R_m = the return on the market post imputation

r_m = the return on the market pre imputation

$q_m^d D_m^{'} t_{mf}$ = the return due to distributed imputation credits

$q_m^r RIC^{'}$ = the return due to retained imputation credits.

Monkhouse argues that the All Ordinaries Accumulation Index will incorporate the effects of capital gains and retained imputation credits but will ignore the effects of distributed imputation credits.[316]

The QCA has adopted the approach of defining the market risk premium as the risk premium that would exist in the absence of dividend imputation. All imputation credits will be incorporated into QR's below rail coal network cash flows. This avoids the problem of double counting of imputation credits.

As noted by Davis,[317] the debate about the impact of the dividend imputation on the equity risk premium has been confused by two issues:

- not all studies have used the same definitions of returns;[318] and

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[316] As a result Monkhouse proposes that the CAPM based return on equity, after corporate tax payments but before investor level tax payments, be adjusted to:

$$k_e^c = E(r) = r_f + b^L\left[E(R_m) - r_f\right] - q^d D t_f - q^r RIC'$$

where

k_e^c is the cost of equity capital applicable to after corporate tax cash flows

$E(r)$ is the expected return on the company's equity before investor level tax payments

$E(R_m)$ is the expected total return on the market and includes the expected returns due to after corporate tax cash flows plus the expected return due to imputation credits

b^L is the beta of the levered company equity

r_f is the risk free rate

q^d is the utilisation of distributed imputation credits

q^r is the utilisation of retained imputation credits

D is the grossed up dividend paid by the company

t_f is the level of franking of the dividend

RIC' is the yield associated with the amount of imputation credits retained by the company relative to the market value of the company's equity.

[317] Davis, K. (1999), 'Dividend Imputation and the Equity Market Premium', Unpublished Research Seminar Paper, 10 September, Dept. of Accounting and Finance, The University of Melbourne, 10 September.

[318] In relation to the calculation of returns, alternative methods include the conventional measure of rates of return, the grossed up rate of return and the partially grossed up rate of return. The conventional measure ignores the impacts of taxation and is regarded as a measure of return post company tax but pre-investor level tax. It is calculated as $r = \frac{[d + \Delta P]}{P_{t-1}}$. Grossed up rates of return occur where the tax credits accompanying a franked dividend are included in the calculation. This measure provides a measure of the investors rate of return before company tax. Thus an investor buying a share at price P at time t-1 and receiving a franked dividend of amount d and a capital gain amount of ΔP would have a grossed up rate of return of $r^g = \frac{\left[\frac{d}{(1-t_c)} + \Delta P\right]}{P_{t-1}}$. Partially grossed up rates of return occur when only part of the tax credit paid out to investors are used. Here some part of company tax can be viewed as a prepayment of personal tax and the remainder viewed as an impost

- not all studies have focussed on the impact of imputation on the equity premium but rather have focussed on the value of the imputation credits.[319] Empirical studies show that imputation franking credits are unlikely to be capitalised into share prices at their full value because:
  - not all investors can use the tax credits;
  - effective tax rates on dividends and capital gains differ between investor groups; and
  - not all tax credits are distributed by the company immediately.

Estimating the impact of dividend imputation on the market risk premium

In the presence of dividend imputation, the market risk premium is adjusted from $(E(R_m) - R_f)$ to $(E(R_m) + \tau - R_f)$ where:

- $E(R_m)$ is the expected market return;
- R_f is the risk-free rate; and
- τ is the adjustment factor for imputation.

To calculate the value of the adjustment, it is necessary to add back the value of the imputation tax credits representing personal taxes that have already been paid. The value of the tax credits can be expressed as a rate of return, τ, by dividing the tax credits by the share price. To adjust the observed return on the market portfolio to an after company tax rate of return, it is necessary to determine the average dividend yield on the market portfolio, the extent to which dividends are franked and the corporate tax rate. For example assume:

- return on market portfolio = 10.50%;
- risk-free rate = 6.50%;
- average annual dividend yield = 4.50%;
- corporate tax rate = 36%; and
- dividend franking = 80%.

Then, per $100, the tax credit received is:[320]

additional to the personal tax system. Let γ be the proportion of franking credits paid out which are utilised to reduce personal tax payments and C be the amount of tax credits associated with the dividend d. The partially grossed up rate of return becomes $r^{pg} = \frac{[d + gC + \Delta P]}{P_{t-1}}$. Davis notes that if the dividends are fully franked, $C = \frac{d \times t_c}{(1 - t_c)}$ and if $\gamma = 1$ then the grossed up return is equivalent to the partially grossed up return and if $\gamma = 0$ then the conventional return is equivalent to the partially grossed up return.

319 See for example the studies by Bellamy (1994), Brown and Clarke (1993), Brunker, Dews and White (1994), Hathaway and Officer (1996) and Walker and Partington (1999) who all attempt to measure the value of imputation credits through the examination of ex-dividend price drop offs. The references are Bellamy, D.E. (1994), 'Evidence of Imputation Clienteles in the Australian Equity Market', *Asia Pacific Journal of Management, v*ol. 11, pp. 275-28; Brown, P. and A. Clarke (1993), 'The Ex-Dividend Day Behaviour of Australian Share Prices Before and After Dividend Imputation', *Australian Journal of Management*, vol. 18, pp. 1-40; Brunker,K., N. Dews and D. White., *Capturing Value from Dividend Imputation,* McKinsey and Company; Hathaway, N. and R.R. Officer (1996) 'The Value of Imputation Credits, Working Paper, Graduate School of Management, The University of Melbourne; and Walker, S. and G. Partington, 'The Value of Dividends: Evidence from Cum-Dividend Trading in the Ex-Dividend Period', *Accounting and Finance*, vol. 39, pp. 275-296.

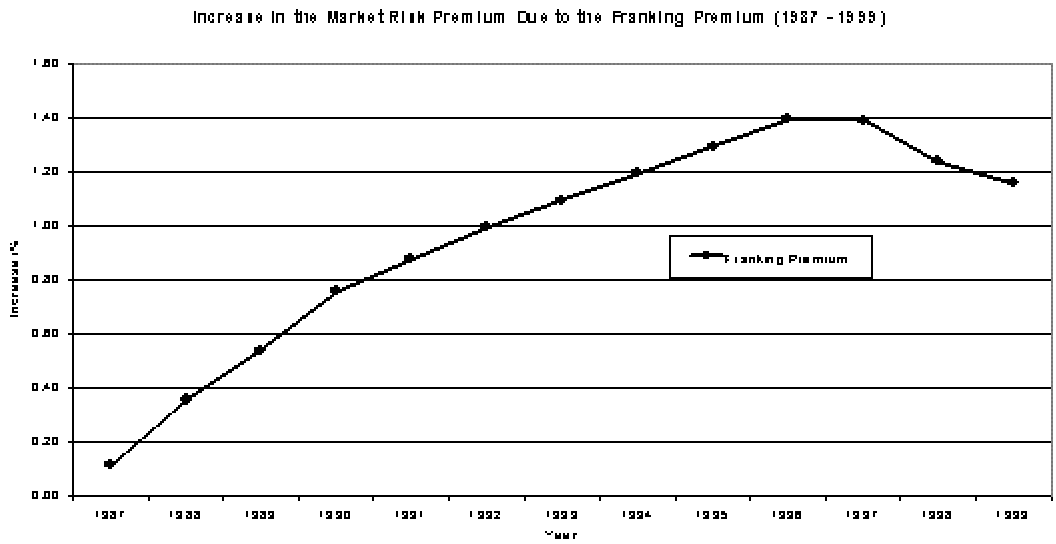
320 This approach is used in Pierson G., R. Brown, S. Easton and P. Howard (1998), *Business Finance*, 7th edition, McGraw Hill Australia, Sydney.

$$\frac{\$4.50 \times 0.80 \times 0.36}{(1-0.36)} = \$2.025 \quad \text{or} \quad \frac{2.025}{100} \times \frac{100}{1} = 2.025\% \ \text{ or approx. } 2.00\%.$$

The unadjusted market risk premium would equal 10.50- 6.50 = 4.00 %. With the adjustment for imputation, the adjusted market risk premium becomes 10.50 + 2.00 – 6.50 = 6.00%.

Figure 12 shows the increase in the market risk premium resulting from the franking premium adjustment factor for each year from the introduction of dividend imputation in 1987 to 1999. In all calculations τ was assumed to equal 0.50. Over the period from 1987 to 1995 the uplift factor trended upwards but has since stabilised. The average uplift factor over the period was 0.89% (that is, less than 1.00 %).

Figure 12



Further calculations were performed to assess the sensitivity of τ across the range of 0.50 to 0.80. The resulting average uplift factors are shown in Table 27. Analysis also shows that as the tax rate and the dividend yield increase, *ceteris paribus*, the value of the uplift factor also increases.

Table 27: Sensitivity of the average franking premium to changes in the adjustment factor for imputation

Adjustment factor for imputation (%)	Average uplift to market risk premium (%)
0.50	0.89
0.60	1.06
0.70	1.24
0.80	1.42

APPENDIX D The relationship between equity, debt and asset betas

The WACC relationship expresses the entity's cost of capital as the weighted average of the required return on its equity and debt. Because of the equivalence between the assets of the entity to a portfolio of the entity's equity and debt with respective weights of $\frac{E}{E+D}$ for equity and $\frac{D}{E+D}$ for debt, the return on assets can be expressed as follows:[321]

$$R_a = R_e\left(\frac{E}{E+D}\right) + R_d\left(\frac{D}{E+D}\right)$$

Substituting CAPM for each of the returns (R_a, R_e and R_d) gives:

$$R_f + b_a\left(R_m - R_f\right) = \left(R_f + b_e\left(R_m - R_f\right)\right)\left(\frac{E}{D+E}\right) + \left(R_f + b_d\left(R_m - R_f\right)\right)\left(\frac{D}{D+E}\right)$$

which is equivalent to:[322]

$$b_a = b_e\left(\frac{E}{D+E}\right) + b_d\left(\frac{D}{D+E}\right)$$

An asset beta represents the risk arising from the sensitivity, or covariance, of the operating cash flows generated by the assets of an entity compared with the market in general. Asset betas are not directly observable and therefore must be derived directly from equity betas. The difference between an asset beta and an equity beta reflects the extent to which debt is used to finance the entity's assets.

[321] It is also possible to show that each dollar of equity can be thought of as a portfolio weighted average of the entity's assets and debt, made up of a long position in the assets and a short position in debt. Here the respective portfolio weights are (1+D/E) on the assets and –D/E on the debt. Hence it is possible to show that:

$$R_e = \left(1+\frac{D}{E}\right)R_a - \left(\frac{D}{E}\right)R_d$$

[322] The derivation is shown below:

$$R_f + b_a\left(R_m - R_f\right) = \left(R_f + b_e\left(R_m - R_f\right)\right)\left(\frac{E}{D+E}\right) + \left(R_f + b_d\left(R_m - R_f\right)\right)\left(\frac{D}{D+E}\right)$$

Substitute $D + E = V$

$$R_f + b_a\left(R_m - R_f\right) = R_f\left(\frac{E}{V}\right) + b_e\left(R_m - R_f\right)\left(\frac{E}{V}\right) + R_f\left(\frac{D}{V}\right) + b_d\left(R_m - R_f\right)\left(\frac{D}{V}\right)$$

$$b_a\left(R_m - R_f\right) = R_f\left(\left(\frac{E}{V}\right) + \left(\frac{D}{V}\right) - 1\right) + b_e\left(R_m - R_f\right)\left(\frac{E}{V}\right) + b_d\left(R_m - R_f\right)\left(\frac{D}{V}\right)$$

$$b_a\left(R_m - R_f\right) = R_f\left(\frac{E+D}{V} - 1\right) + b_e\left(R_m - R_f\right)\left(\frac{E}{V}\right) + b_d\left(R_m - R_f\right)\left(\frac{D}{V}\right)$$

$$b_a = \frac{b_e\left(R_m - R_f\right)\left(\frac{E}{V}\right) + b_d\left(R_m - R_f\right)\left(\frac{D}{V}\right)}{\left(R_m - R_f\right)}$$

$$b_a = b_e\left(\frac{E}{V}\right) + b_d\left(\frac{D}{V}\right)$$

$$b_a = b_e\left(\frac{E}{E+D}\right) + b_d\left(\frac{D}{E+D}\right)$$

It is obvious from above that the beta of an entity's assets is equal to the betas of the entity's equity and debt weighted by the respective weights for equity and debt. Whilst equity and debt betas can be calculated via CAPM-based methods, the asset beta can only be inferred via the above relationship.

Issues in the estimation of the equity beta

An entity's equity beta (β_e) reflects both the market risk associated with its assets and the financial risk borne by shareholders due to the entity's use of debt financing. CAPM assumes that a linear relationship exists between an entity's gearing and the premium associated with that gearing.[323] Two factors have been identified as key determinants of an entity's equity beta:

- financial risk arising from financial leverage – the ratio of debt to equity, where a higher level of debt implies a higher beta; and
- asset risk arising from the entity's sensitivity to cash flow movements – relative to overall economic activity, where more cyclical cash flows are associated with higher betas.

Typically, equity betas are estimated using historical data through the application of the market model[324] which is derived from CAPM as follows:

$$R_i = R_f + b_i\left(R_m - R_f\right)$$
$$R_i = R_f + b_i R_m + b_i R_f$$
$$R_i = R_f\left(1 - b_i\right) + b_i R_m$$
$$R_i = a_i + b_i R_m$$

where

a_i is equal to $R_f\left(1 - b_i\right)$

b_i is the equity beta

[323] This theoretical position is not supported empirically. See Marston, F. and S. Perry, (1996) 'Implied Penalty for Financial Leverage: Theory Versus Empirical Evidence', *Quarterly Journal of Business and Economics,* vol. 35(2), pp. 77-97, who find that the relationship between equity betas and financial leverage is non-linear with a higher penalty in the calculation of asset betas for those firms with high levels of leverage relative to firms with low leverage.

[324] Alternatively beta can be estimated using the following excess return model. The beta coefficients from either model should not be significantly different provided interest rates have not moved significantly during the estimation period in which case they will still be similar. If the risk-free rate is constant the models yield exactly the same estimate of beta.

$$R_i - R_f = a + b_i\left(R_m - R_f\right)$$

where

$a =$ is assumed to equal zero.

To demonstrate the equivalency with the market model given that α is assumed to equal zero then expanding the equation gives:

$$R_i - R_f = a + b_i\left(R_m - R_f\right)$$
$$R_i - R_f = a + b_i R_m - b_i R_f$$

Set a equal to zero:

$$R_i = 0 + b_i R_m - b_i R_f + R_f$$
$$R_i = 0 + b_i R_m + R_f\left(1 - b_i\right)$$
$$R_i = R_f\left(1 - b_i\right) + b_i R_m$$

The estimation of equity betas is not without controversy. There are numerous issues relevant to its estimation that the Authority had to consider including the following:[325]

- the choice of return measure – for example, whether returns should be discrete or continuously compounded, whether raw or excess returns should be used and whether nominal or real returns should be used. Typically the risk-free rate and market risk premium are both expressed as discretely compounded returns. However, consistent with market efficiency and continuous trading in financial markets, it is preferred that equity market returns are expressed as continuously compounded rates.[326] Also, interest rate volatility is usually quite low over short term intervals such as months. Therefore the use of excess returns will not add further precision to the beta estimate over the market model. Hence, to generate a nominal rate of return on equity for individual stocks and the market portfolio the Authority used monthly continuously compounded raw returns. These returns were adjusted for both dividends and capitalisation changes;

- the sampling interval for the data and the length of the estimation period. Estimates using short interval data (measured at daily or weekly intervals) are systematically biased, such that highly traded securities are over stated whilst those of infrequently traded securities are understated. Alternatively, use of long intervals (measured quarterly or annually), lowers the number of data points used in the estimation process and diminishes the accuracy of beta measures. Empirical evidence[327] shows that beta estimates using monthly data estimated over 4 to 5-year intervals provide the most reasonable trade off between the number of observations and the stability of beta estimates. The Authority has applied a 5-year estimation interval;

- the choice of proxy for the market portfolio. By definition, the measurement of a beta is relative to a market risk premium, which in turn relates to a single specific market. Accordingly, beta estimates for a company differ depending on which stock market index is used – systematic risk is largely country specific and meaningful beta estimate can only be derived using a national index from a company's own country of operation.[328] Therefore, caution is required in comparing betas of companies operating in similar industries but in different countries, or using alternative proxies for the market portfolio[329] as betas reflect the risk of a company relative to the market. Differences in the market composition of national share markets do not facilitate direct comparison of betas. As outlined in Table 28, the Australian stock market has a greater component of resource stocks, which account for 16.5% of total Australian market capitalisation. This suggests that the ASX may have a different risk profile compared with the US stock market (where resources stock account for 6.9% of total US stock market capitalisation,

[325] An overview of each of these issues is discussed in T. Brailsford, R. Faff and B. Oliver, 1997, *Research Design Issues in the Estimation of Beta,* McGraw Hill, Sydney.

[326] There is a direct relationship between discretely compounded and continuously compounded returns such that:

$$R_{cc} = \ln(1 + R_{dc})$$

where

$R_{cc} =$ continuously compounded returns

$R_{dc} =$ discretely compounded returns

[327] Brailsford, T., R. Faff and B. Oliver (1997), *Research Design Issues in the Estimation of Beta,* McGraw Hill, Sydney.

[328] The World Bank Policy Research Working Paper 1698 (section 6.1 pages 24 to 25) found that the beta estimates of US telecommunications operator, AT & T, which is listed in US, UK and other foreign stock exchanges, differs depending on which stock exchange index is used.

[329] For example, from May 1992 to December 1999, the correlation between the Bloomberg measure for the All Ordinaries Accumulation Index (ASA30) and the Australian Graduate School of Management (AGSM) Risk Measurement Service value weighted market index was 0.97. Whilst the means of the two market portfolio proxies are similar the variance of the AGSM measure is less than the Bloomberg data. This will have the impact of marginally increasing the beta coefficients estimated using AGSM data over Bloomberg measures subject to the covariance of the individual stock relative to the market. Whilst this example highlights the problem of market portfolio selection it also highlights the instability of beta measures subject to data provider.

and 7.4% of total UK stock market capitalisation). The market portfolio was proxied in Australia using the All Ordinaries Accumulation Index in Australia, the S&P 500 for US data and the Financial Times Stock Exchange 100 Index in the UK.

Table 28: Composition of market indices

Index (at 30 Nov 1998)	Resource Sector	Industrial Sector	Market Capitalisation
Australian All Ordinaries Accumulation Index	16.5%	83.5%	A$417.0 billion
US Standard & Poors 500	6.9%	93.1%	US$10.6 trillion
UK FTSE 100	7.4%	92.6%	£1.04 trillion

- the selection of an appropriate method to estimate beta so as not to violate distributional assumptions and to decide how outliers will be considered. Beta is typically estimated using the market model, by an ordinary least squares approach which has the following limiting assumptions:

  - the errors from the regression have a mean of zero;

  - the errors have a common constant and finite variance (homoscedasticity);

  - the errors are not correlated with each other over time, nor with the market risk premium;

  - the dependant and explanatory variables are measured without error. Violation of this assumption results in an errors in variables problem.[330] However, the only effect of the presence of measurement error in the dependent variable will be to increase the error variance. The slope parameter will be unbiased and consistent. If the explanatory variable is measured with error, this will result in an errors in variables problem biasing the beta coefficient and making it inconsistent. The degree of bias and inconsistency are related to the variance of the measurement error and will result in an underestimate of the true regression parameter or beta coefficient if ordinary least squares techniques are applied;[331] and

  - the error term is uncorrelated with that from another regression.

  Using these assumptions, the estimated coefficients of $\hat{a}_i$ and $\hat{b}_i$ are the best linear unbiased estimates (BLUE) of the parameters a_i and b_i.[332] If the assumptions are violated two results can occur:

  - biased sample estimates of the coefficients; and

  - standard formulas and tests for statistical significance are invalid.

[330] See Pindyck, R.S. and D.L. Rubinfeld (1991), *Econometric Models & Economic Forecasts*, 3rd edition, McGraw Hill, New York, pp. 159-160.

[331] Officer notes that betas are subject to large measurement error. See Officer, R. (1999), 'Capital Structure and Betas', Valuation and the Cost of Capital under an Imputation Tax System, seminar at the Melbourne Business School, 15 September.

[332] The presence of a BLUE estimator suggests that the relationship is linear and that the estimated coefficients are efficient and unbiased estimates of the 'true' coefficients.

The estimation of the coefficients using OLS techniques have typically produced unstable estimates of beta due to findings of heteroscedasticity[333] and autocorrelation[334] in the residuals. Other findings suggest the presence of non-normality in the residuals, outliers, non-linearity in the relationship between the return on the asset and the market return, non-stationarity in beta estimates, or the possibility of omitted variables such as firm size or seasonalities. Thus, in the estimation of beta, the Authority has used appropriate diagnostics to ensure beta estimates are consistent with BLUE estimation requirements so that beta estimates are not biased;

- thin trading bias and the choice of a variety of methods to avoid thin trading biases. Thin trading bias arises when shares go through extended periods of non-trading despite movements in the market index during the same period.[335] Several methods are available for adjust beta for thin trading bias such as the methods suggested by Scholes & Williams[336] and Dimson;[337]

- issues of beta stability including whether beta mean reverts, how beta behaves in the presence of structural breaks and the time variation of beta. Brailsford et. al.[338] identified two related notions of beta instability – 'inter-period' instability and 'intra-period' instability. The former arises due to instability of beta between the estimation period and the 'application' period. The other arises due to instability of beta during the estimation period. The primary reasons for inter-period instability are due to:

  - mean reversion in the beta where beta has been found to have a regression tendency over time towards the grand mean[339] of 1. Over time, high betas tend to move down and low betas tend to move up;[340] and

  - structural breaks in the underlying economy involving clear delineation in the underlying market that affect all participants – examples include the shift from a classical to the imputation taxation system in 1987 and the floating of the Australian dollar in December 1983. Care must be taken in the identification of break points as there may be prior learning about the break event, learning of the consequences of the event or the break may involve a structural change over several months or years.

[333] Non-constant or time-varying volatility of the regression errors. In the presence of heteroscedasticity, the OLS estimates are still unbiased and consistent but are not efficient or asymptotically efficient. As a result, the regression coefficient will be less accurate, the estimated covariance matrix will be biased and the traditional statistical tests will not be valid.

[334] Correlation between errors measured at different times.

[335] The returns on the shares in non-trading periods are zero. Hence, non trading will cause a reduction in the correlation and covariance between the share return and the market return.

[336] Scholes, M. & Williams, J.(1977), 'Estimating Betas from Non-Synchronous Data', *Journal of Financial Economics*, vol. 5(3), pp. 309-327.

[337] Dimson, E.(1979), 'Risk Measurement when Shares are Subject to Infrequent Trading', *Journal of Financial Economics*, vol. 7(2), pp. 179-226.

[338] T. Brailsford, R. Faff and B. Oliver, 1997, *Research Design Issues in the Estimation of Beta,* McGraw Hill, Sydney.

[339] The grand mean represents the mean of all the individual means estimated.

[340] Beta have been found to have a regression tendency over time towards the grand mean of 1. Over time, high betas tend to move down and low betas tend to move up. The Australian study by Castagna, A. and Z. Matolcsy (1978) 'The Relationship between Accounting Variables and Systematic Risk and the Prediction of Systematic Risk', *Australian Journal of Management,* vol. 3, pp. 113-26, found that it was possible to adjust the estimated OLS beta as follows:

$$b_i^{CM} = 0.541 + 0.464\hat{b}_i$$

A study by Brooks, R. and R. Faff (1997) 'A Note on Beta Forecasting', *Applied Economics Letters,* vol. 4, pp. 77-78 compared a series of adjustments to betas estimated from a market model during the period 1983-1987 and also found that the adjustment based on the following provided a very useful adjustment:

$$b_i^{BF} = 0.50 + 0.50\hat{b}_i$$

The primary reasons for intra period instability are due to:

- changes in firm specific factors during the estimation period such as a change in core business or business divestment; and

- changes in market factors such as the level of financial leverage or shifts in the business cycle or sudden major moves by competitors.

The Authority regards the stability of beta as an important issue in identifying the appropriate equity beta for QR's below rail coal network. Only limited empirical evidence from the Australian markets supports the mean reversion of beta.[341] The raw beta values, which were derived from historical data, can be adjusted based on the assumption that beta factors change over time especially in industries where there is considerable structural reform underway.[342] The true beta has a tendency over time to move toward the market average of one and this adjustment may be represented as:

Adjusted (future) beta = raw beta x (0.67) + 0.33.

This is the approach adopted by Bloomberg, which appears to be more generally accepted by practitioners.[343]

- the possibility of omitted variables in the estimation of beta due to entity size characteristics, seasonalities, changes in industry structure or the regulatory framework. For example, empirical evidence suggests that there is an inverse correlation between market capitalisation and systematic risk (beta). That is, smaller entities tend to have higher betas than larger entities.[344]

Issues in the estimation of debt betas

The debt beta (β_d) reflects the financial risk borne by shareholders due to the entity's use of debt financing. The CAPM can be used to identify the debt beta.

[341] See Castagna, A. and Z. Matolcsy (1978), 'The Relationship Between Accounting Variables and Systematic Risk and the Prediction of Systematic Risk', *Australian Journal of Management, v*ol. 3, pp. 113-26 and Brooks, R. and Faff, R. (1997), 'A Note on Beta Forecasting', *Applied Economics Letters,* vol. 4, pp. 77-78.

[342] International studies supporting the use of adjusted betas include Sharpe, W.F., Alexander, G.J. and Bailey, J.V. (1995), *Investments*, 5th edition, Englewood Cliffs, Prentice Hall, (rationale for adjusting beta section); Blume, M.E. (1971), 'On the Assessment of Risk', *Journal of Finance*, March, pp. 1-10; and Blume, M.E. (1975), 'Betas and their Regression Tendencies', *Journal of Finance*, June, pp. 785-795.

[343] It is worth noting that Merrill Lynch adjusts beta by the following formula:
Adjusted (future) beta = Raw Beta * (0.65) + (0.35)*1.

[344] Berk, J.B. (1995), 'A Critique of Size-related Abnormalities', *Review of Financial Studies*, (Summer), pp. 275-286.

$$R_d = R_f + b_d \left[R_m - R_f \right]$$

Transformed

$$b_d = \frac{\left(R_d - R_f \right)}{\left[R_m - R_f \right]}$$

where

R_f = the risk free rate

R_m = the expected return on the market portfolio of risky assets

R_d = the expected return on debt

$b_d = \dfrac{Cov(R_d, R_m)}{Var(R_m)}$ = the debt beta

$\left[R_m - R_f \right]$ = the equity risk premium

The debt beta calculation is very sensitive to the size of the market risk premium. If the market risk premium increases this will have the impact of reducing the size of the debt beta. The ACCC have used the above CAPM-based approach to calculate the debt beta.[345]

It is acknowledged that the cost of debt funding can distort the level of the return to debt holders. However, such transaction costs should be treated as an expense to the business rather than an adjustment to the cost of debt. Equity capital also involves administrative and underwriting costs[346] which would distort the return to equity holders by influencing the initial issuance price of the equity. Trading in equity markets also involves brokerage fees. The QCA therefore considers that an adjustment to the debt beta for this is inappropriate and therefore adopts the standard CAPM debt beta estimation approach.

Issues in the estimation of asset betas

The CAPM assumes a linear relationship between the equity beta and the gearing of an entity. Hence, it is possible to calculate asset betas from equity betas. The asset beta refers to the beta applicable to the assets of an entity that has no debt. The gearing of the entity needs to be taken into account in estimating asset betas because default risk is incorporated in equity values and this needs to be removed to arrive at the entity's risk profile independent of its financial structure. The adjustment of estimated equity betas to remove the financial risk associated with a security, leaving the risk of the asset encapsulated in the asset beta (β_a) is known as de-levering[347] of the equity beta.

The textbook approach to the process of de-levering and re-levering generally involves the following procedural steps:

[345] Australian Competition and Consumer Commission, 'NSW and ACT Transmission Network Revenue Caps: Decision', January 2000, pp. 35-36; Office of the Regulator-General, Victorian Ports Price Review, May 2000, p. 41; Office of the Regulator-General, 2001 Electricity Distribution Price Review: Draft Decision, May 2000, p. 161. ORG's earlier decisions discounted the risk premium on debt by 50 basis points which effectively reduced the debt beta and increased the equity beta (eg. Victorian Gas Access Arrangements for Multinet, Westar and Stratus). However, between the draft and final decision in Office of the Regulator General, Victoria, Electricity Distribution Price Determination 2001-2005, Volume 1 – Statement of Purpose and Reasons, p. 120, ORG switched from applying debt betas at 0.20 to application of zero debt betas.

[346] Administrative costs can amount to about 1.5% of the value of the share issue and underwriting costs can amount to up to 1% of the value of the share issue.

[347] This process is also called de-gearing of the equity beta.

- estimate the equity beta of a comparable company or group of companies;
- convert the comparator's estimated equity beta to its asset (or de-levered) beta using a de-levering formula and the comparator's current leverage ratio. The purpose of this adjustment is to purge the effects of financial (or leverage) risk and leave the risk that reflects the underlying business risk only;
- re-lever the asset beta obtained in the previous step using the entity of concern's current leverage in conjunction with a relevering formula; and
- the resultant figure should then be an estimate of the equity beta for the entity of concern.

It should also be noted that when assessing the asset betas of comparable companies, prior to re-levering it is necessary to select a representative asset beta or asset beta range for the purpose. Technical methods exist for this purpose including the use of averaging processes such as arithmetic averaging or use of 'variance minimising' methods such as that of Vasicek[348] where beta estimates are weighted on the basis of minimising the variance in the average beta for the comparable group. It is uncertain as to how well such methods perform in practice which is itself an unresolved empirical issue.[349] A superior and less mechanistic method that acknowledges the problems of beta measurement would be to place greater weighting to those firms which best reflect the operational characteristics of the firm being proxied.

It is worth noting that while it is possible to de-lever the equity betas of particular companies to derive asset betas, and to then re-lever betas to reflect a more appropriate or comparable financial structure, this technique is subject to considerable estimation error. As such it can give a misleading impression as to the precision of the entire methodology.[350]

There are several approaches to de-levering and re-levering betas and there is no consensus about which is the most appropriate method. The QCA identified the following methods extensively used by academics and regulators to de-lever and re-lever equity betas. They have been broadly categorised by the QCA as:

- the standard or textbook approaches, including both the Brealey Myers and Conine approaches;
- the Davis approach; and
- the Appleyard & Strong / Monkhouse approach.

Each of these approaches are discussed below. As noted by the ORG:[351]

> "The impact on the estimated after-tax WACC of using a different debt beta and levering approaches [is] not significant, however, *provided* that the same approach is used when deriving a proxy asset beta from the comparable entities, as is used when deriving a proxy asset beta back into an equity beta."

[348] O. Vasicek (1973), 'A Note on Using Cross-Sectional Information in Baysian Estimation of Security Betas', *Journal of Finance*, vol. 28, pp. 1233-1239.
[349] See Lally M. (1998), 'An Examination of Blume and Vasicek Betas', *The Financial Review*, vol 33, pp. 183-198.
[350] Grant Samuel and Associates Pty Ltd, Independent Expert's Report, 6 July 1998, p. 61 in Aberfoyle Limited Part B Statement re: Western Metals Offer and Westpac Corporate Finance as reported in Office of the Regulator-General, Weighted Average Cost of Capital for Revenue Determination: Gas Distribution, Staff Paper No. 1, May 1998, p. 28.
[351] ORG, Victorian Ports Price Review – Draft Decision, May 2000, p. 47.

The main reason for differing approaches may be attributed to the fact that often the issue of cost of capital is divorced from the underlying cash flow of the regulated business. There are a myriad number of ways to estimating cash flows and each variation has implications for the determination of cost of capital. For example, the basic difference between the Officer approach (and CS First Boston) and the Monkhouse approach (recommended by Professor Davis and adopted by ACCC, ORG and IPART) is that with the Monkhouse approach, the value of the imputation tax credit is taken into account in the CAPM. Whereas, with the Officer approach, the value of imputation credits is taken into account in the cash flows or directly in the WACC formula. Correctly applied, both approaches are consistent. Therefore, from a theoretical perspective, either approach is sound and the only issue comes down to which is more empirically valid or practically easier to apply because they require different approaches to estimation.

Standard or textbook approaches

There are the following variations of de-levering formulae, which appear in textbooks such as Brealey and Myers[352] that are regarded as standard. The first two formulae outlined below are the most common but rely on an assumption of active debt management while the other two are often provided by textbooks as alternatives but rely on an assumption of passive debt management.

The debt management practices of the entity have direct implications for the choice of delevering formula. The academic literature identifies two approaches:

- active debt management, where the entity is assumed to maintain a predetermined gearing ratio. Here the level of debt in each period is contingent on the calculated value of the entity at the beginning of the period; and

- passive debt management, where the entity is assumed to maintain a pre-specified debt schedule, specified in advance, regardless of the outcome of future cash flows.

Brealey Myers approach (active debt management, non-zero debt beta)[353] - a common textbook approach, advocated by Officer, assumes that an adjustment of debt in each period to keep it a constant proportion of the market value of the enterprise.[354] This approach is widely used and has been adopted by CS First Boston.[355] The approach is a direct derivation from the asset beta formula.[356] It is represented by the following equation:

[352] Brealey, R. and Myers, S., *Principles of Corporate Finance*, Sixth Edition, 1999, McGraw-Hill, New York.

[353] This approach can be expressed for zero debt beta which assumes that the only impact which debt has on the value of the firm arises out of the tax deductibility of debt interest expense (hence the debt beta is set to zero). This approach is a common simplification of the above approach and is expressed as follows:

$$b_e = b_a \times \left(1 + \frac{D}{E}\right) \qquad \text{and} \qquad b_a = \frac{b_e}{\left(1 + \frac{D}{E}\right)}$$

This approach was originally advocated by Hamada, R. S., 'Portfolio Analysis, Market Equilibrium and Corporation Finance', *Journal of Finance*, vol. 24(1), pp. 13-31.

[354] R.R. Officer, Comments on a Report Prepared by Professor Kevin Davis on the WACC for the Gas Industry, 8 April 1998, Paper Commissioned by the Victorian Office of Regulator General.

[355] CS First Boston, Weighted Average Cost of Capital: Gascor Successor Entities and Gas Transmission Corporation, Commissioned by the Energy projects Division of the Department of Treasury and Finance Victoria, 5 September 1997.

[356] The Brealey Myers non-zero debt beta equity beta formula is derived from the WACC formula as follows:

$$b_e = b_a + (b_a - b_d) \times \frac{D}{E} \quad \text{and} \quad b_a = \frac{b_e + b_d \times \frac{D}{E}}{1 + \frac{D}{E}}$$

where:

β_e = equity beta

β_a = asset beta

β_d = debt beta

D = value of debt

E = value of equity

Conine approach (passive debt management, non-zero debt beta)[357] - a less common approach assumes that an initial proportion of the overall enterprise value is borrowed and held with pre-determined debt and interest payments (which may be referred to as a passive debt management policy).[358]

$$b_e = b_a + (b_a - b_d) \times (1 - T) \times \frac{D}{E} \quad \text{and} \quad b_a = \frac{b_e + b_d \times (1-T)\frac{D}{E}}{1 + (1-T)\frac{D}{E}}$$

where:

T = corporate tax rate

$$b_a = b_e\left(\frac{E}{D+E}\right) + b_d\left(\frac{D}{D+E}\right)$$

$$b_e = \frac{b_a - b_d\left(\frac{D}{E+D}\right)}{\left(\frac{E}{E+D}\right)}$$

$$b_e = \left[b_a - b_d\left(\frac{D}{E+D}\right)\right] \times \left(\frac{E+D}{E}\right)$$

$$b_e = b_a\left(\frac{E+D}{E}\right) - b_d\left(\frac{D}{E+D}\right) \times \left(\frac{E+D}{E}\right)$$

$$b_e = b_a\left(\frac{E}{E}\right) + b_a\left(\frac{D}{E}\right) - b_d\left(\frac{D}{E}\right)$$

$$b_e = b_a + (b_a - b_d)\left(\frac{D}{E}\right)$$

357 A simplification of the above approach is to implicitly assume a zero debt beta and hence a cost of borrowing equal to the risk-free rate. The resulting delevering formula can be expressed as follows:

$$b_e = b_a \times \left[1 + (1 - T) \times \frac{D}{E}\right] \quad \text{and} \quad b_a = \frac{b_e}{1 + (1-T)\frac{D}{E}}$$

358 W. Sharpe, G. Alexander and J. Bailey (1995), *Investments*, 5th ed., Englewood Cliffs, Prentice Hall, p. 533. This approach was developed by T. Conine, (1980) 'Corporate Debt and Corporate Taxes: An Extension', *Journal of Finance,* vol. 35, pp. 1033-6.

Davis approach

After critiquing the standard textbook approach, Davis[359] advocates an approach, which incorporates an imputation adjustment on the passive debt management approach and results in the following formula:

$$b_e = b_a \times \left\{1 + \left[1-(1-g)\times T\right]\times\frac{D}{E}\right\} \quad \text{and} \quad b_a = \frac{b_e}{1+\left[1-(1-g)\times T\right]\times\frac{D}{E}}$$

where:

γ = gamma[360]

The above approach may be expanded to accommodate a non-zero debt beta as outlined in the formula below[361]:

$$b_e = b_a + (b_a - b_d)\times\left[1-(1-g)\times T\right]\times\frac{D}{E} \quad \text{and} \quad b_a = \frac{b_e + b_d \times\left[1-(1-g)\times T\right]\times\frac{D}{E}}{1+\left[1-(1-g)\times T\right]\times\frac{D}{E}}$$

Davis[362] argues that the use of the standard textbook approach, such as Brealey Myers, ignores the impact of corporate tax on the leverage factor and is correct only in two circumstances:

- if there is no income tax; or
- if the imputation system operates perfectly (with gamma = 1) in the sense that all corporate tax payments are washed out by offsetting reductions in shareholder tax payments.

Appleyard and Strong / Monkhouse approach

Appleyard and Strong (non-zero debt beta) - Appleyard and Strong propose an alternative relationship between levered and unlevered asset betas as a result of adopting an active debt management policy.[363] The formula is outlined as follows:

$$b_e = b_a + (b_a - b_d)\times\left(1-\frac{r_d}{1+r_d}\times T\right)\times\frac{D}{E}$$

$$b_a = \frac{b_e + b_d \times\left(1-\frac{r_d}{1+r_d}\times T\right)\times\frac{D}{E}}{1+\left(1-\frac{r_d}{1+r_d}\times T\right)\times\frac{D}{E}}$$

where:

r_d = nominal pre-tax cost of debt

[359] K. Davis (1998), 'The Weighted Average Cost of Capital for the Gas Industry', March..

[360] Gamma is the proportion of imputation tax credits, which can, on average, be utilised by shareholders of the enterprise to offset tax payable on other income.

[361] It is noted that when IPART in 'The Rate of Return for Electricity Networks: Discussion Paper' (November 1998) used this formula they replaced E (equity) with (D+E) in the numerator calculation of the debt equity ratio. No rationale was provided for this change. The impact of such a change would be to express debt relative to the total value of the entity rather than to equity.

[362] K. Davis (1998), 'The Weighted Average Cost of Capital for the Gas Industry', p. 11.

[363] Appleyard, T. and N. Strong (1989), 'Beta Geared and Ungeared: The Case of Active Debt Management', *Accounting and Business Research*, Spring.

Monkhouse (non-zero debt beta) - Monkhouse modifies the Appleyard and Strong approach by replacing the corporate tax rate (T) with the effective tax rate (T_e) and recognising imputation tax credits.[364]

$$b_e = b_a + (b_a - b_d) \times \left(1 - \frac{r_d}{1+r_d} \times T_e\right) \times \frac{D}{E}$$

$$b_a = \frac{b_e + b_d \times \left(1 - \frac{r_d}{1+r_d} \times T_e\right) \times \frac{D}{E}}{1 + \left(1 - \frac{r_d}{1+r_d} \times T_e\right) \times \frac{D}{E}}$$

where:

T_e is the effective tax rate equivalent to $T_c(1-\gamma)$.

The approach to de-levering and re-levering betas should not only recognise the uncertainty regarding the method to apply but should also consider the uncertainty in estimating the relative gearing ratio in the first instance. This is because there is the issue of whether the beta measured over an observed period reflects the historical gearing level reported in the balance sheet or rather the market expectation as to future gearing levels. Also, with the widespread use of hedging instruments, there are often practical difficulties in estimating an enterprise's debt costs relative to the risk-free rate from publicly available information. Any estimate of the debt beta may therefore be compromised.[365]

The ACCC recognises that there are a number of formulae used to convert an asset beta to an equity beta and considers the Monkhouse approach to be the most appropriate.[366] During 1999 whilst considering Gas Access arrangements, IPART switched from the extended non-zero debt beta Davis formula[367] to the Monkhouse formula.[368] In the Draft Decision for the access arrangement for AGL Gas Network Limited, IPART[369] used the Monkhouse formula. ORG originally adopted the zero debt beta Davis approach in May 1998[370] but also applied the Monkhouse formula[371] in the final decision in October 1998. Macquarie Risk Advisory Services Limited[372] found that the Monkhouse approach produced a very similar result to the widely used standard textbook approach and advocated by both Officer and CS First Boston.[373] As noted by ORG:

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[364] Monkhouse, P. (1997), 'Adapting the APV Valuation Methodology and the Beta Gearing Formula to the Dividend Imputation Tax System', *Accounting and Finance*, vol. 37.

[365] Macquarie Risk Advisory Services Limited, Weighted Average Cost of Capital – Further Issues, 1 September 1998, commissioned by the Victorian Office of Regulator General in the determination of gas access arrangements.

[366] Australian Competition and Consumer Commission, NSW and ACT Transmission Network Revenue Caps: Decision, January 2000, page 36. Australian Competition and Consumer Commission, Statement of Principles for the Regulation of Transmission Revenues (Draft), 27 May 1999, p. 81.

[367] Independent Pricing and Regulatory Tribunal (IPART) of New South Wales, Access Arrangement –Albury Gas Company Limited- Draft Decision, July 1999, p. 26.

[368] Independent Pricing and Regulatory Tribunal (IPART) of New South Wales, Access Arrangement –Albury Gas Company Limited- Final Decision, December 1999, p. 26.

[369] Independent Pricing and Regulatory Tribunal (IPART) of New South Wales, Access Arrangements for AGL Gas Network Limited Natural Gas System in New South Wales. October 1999, p. 64.

[370] Office of Regulator General, Victorian Gas Transmission Access Arrangements Draft Decision, May 1998, p. 216.

[371] Office of Regulator General, Victorian Gas Transmission Access Arrangements Final Decision, 6 October 1998, footnote 87, p. 209.

[372] Macquarie Risk Advisory Services Limited (1988), Weighted Average Cost of Capital: Further Issues, report commissioned by the Victorian Office of the Regulator General.

[373] Macquarie Risk Advisory Services Limited, Weighted Average Cost of Capital – Further Issues, 1 September 1998, p. 9, commissioned by the Victorian Office of Regulator General in the determination of gas access arrangements.

> "The consensus of experts appears to be that CSFB's approach estimates the upper limit of the debt beta (that is, it assumes that all of the default risk is systematic) and Davis' approach provides the lower limit (that is, it assumes that none of the default risk is systematic), and that the real number must be somewhere between."

As discussed above, there is a range of alternative options available for the estimation of beta, along with the other assumptions required for the determination of a return on equity under CAPM. The appropriate approach would be to select a method for de-levering and re-levering betas which reflects an active debt management strategy (non–zero debt beta).[374] Consistent with the approach adopted by QCA to calculate WACC,[375] the Authority has decided to apply the active debt management, non-zero debt beta Brealey and Myers model when de-levering and re-levering betas.

[374] Whereby QR would adjust its gearing level contingent on change in the entity's cash flows despite the possible perception by financial markets of the low risk nature of QR's debt by virtue of government ownership and economies of scale associated with QTC's debt raising activities.
[375] Whereby all imputation and taxation impacts are captured in the cash flows rather than the WACC.

APPENDIX E Alternative Measures of WACC

Classical tax system

As noted by Officer[376], under a classical tax system, the appropriate definition of a company's pre-tax weighted average cost of capital can be expressed as follows:

Cash Flow	WACC
X_0	$r_o = \frac{r_e}{(1-T)}\frac{E}{(E+D)} + r_d\frac{D}{(E+D)}$ where r_e is the return on equity r_d is the return on debt (the cost of debt) E is the market value of equity D is the market value of debt

The amount of tax collected from the company under a classical tax system by the government can be found as $X_g = T(X_0 - X_d)$. Hence,

$$X_0 = T\left(X_0 - X_d\right) + X_e + X_d$$

which converts to:

$$X_0(1-T) = X_e + X_d\left(1-T\right)$$

The after-tax WACC under a classical tax system can be expressed as either:

Cash Flow	WACC
$X_0(1\text{-}T)$	$r_1^c = r_e\frac{E}{\left(E+D\right)} + r_d\left(1-T\right)\frac{D}{\left(E+D\right)}$
$X_0 - \left(X_0 - X_d\right)T_c$	$r_2^c = r_e\frac{E}{\left(E+D\right)} + r_d\frac{D}{\left(E+D\right)}$

Dividend imputation system

Under the dividend imputation tax system, shareholders recover, via imputation tax credits, some proportion of the corporate taxes that have already been paid. This has two effects relevant to the calculation of WACC. First, it decreases the effective corporate tax rate and thereby increases the cash flows to shareholders. Second, the decrease in the effective tax rate will reduce the effective tax shield provided by debt relative to equity. Therefore, under dividend imputation, it is necessary to allow for increased cash flow to shareholders and the increased after tax cost of debt.

376 Officer, R.R. (1994), 'The Cost of Capital under an Imputation Tax System', *Accounting and Finance*, vol. 34(1), pp. 1-18.

In the presence of dividend imputation, the effective tax rate changes from T_c to $T_e = T_c(1-\gamma)$ where:

- Tc is the statutory tax rate (equivalent to the classical tax rate); and
- ? is the value of imputation credits and represents the proportion of tax collected from the company which gives rise to the tax credit associated with a franked dividend.

In the presence of dividend imputation, the appropriate definition of a company's pre-tax weighted average cost of capital can be expressed as:

Cash Flow	WACC
X_0	$r_o = \frac{r_e}{(1-T_c(1-g))}\frac{E}{(E+D)} + r_d\frac{D}{(E+D)}$

Under dividend imputation, the effective level of company tax is defined as:

$$
\begin{aligned}
X_g &= T(X_0 - X_d) - gT(X_0 - X_d) \\
&= T(X_0 - X_d)(1-g)
\end{aligned}
$$

Hence:

$$X_0 = (X_0 - X_d)T_c(1-g) + X_e + X_d$$

which converts to:

$$X_0(1-T_c(1-g)) = X_e + X_d(1-T_c(1-g))$$

In the presence of dividend imputation, the appropriate definition of a company's post-tax weighted average cost of capital can be expressed as:

Cash Flow	WACC
$X_0(1-T_c)$	$WACC\ 1 = r_e\frac{(1-T_c)}{(1-T_c(1-g))}\frac{E}{(E+D)} + r_d(1-T_c)\frac{D}{(E+D)}$
$X_o(1-T_c(1-g))$	$WACC\ 2 = r_e\frac{E}{(E+D)} + r_d(1-T_c(1-g))\frac{D}{(E+D)}$
$X_0 - (X_0 - X_d)T_c(1-g)$	$WACC\ 3 = r_e\frac{E}{(E+D)} + r_d\frac{D}{(E+D)}$
$X_0(1-T_c) + gT_c(X_0 - X_d)$	$WACC\ 4 = r_e\frac{E}{(E+D)} + r_d(1-T_c)\frac{D}{(E+D)}$