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WACC for TPI's Iron Ore Railway

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1. SUMMARY

CRA was retained by the Economic Regulation Authority (Authority or ERA) to provide recommendations on the WACC methodology and parameter values considered by the consultant to be appropriate for the Authority's 2009 Weighted Average Cost of Capital (WACC) for The Pilbara Infrastructure's (TPI's) iron ore railway in the Pilbara. We summarise below our analysis of parameters for the WACC and the WACC calculation, and then provide our comments on the issue of compensation for asymmetric risk.

1.1. WACC CALCULATION

Consistent with the Authority's established practice, we calculate the WACC for TPI's iron ore railway using the Officer version of the Capital Asset Pricing Model (CAPM).

1.1.1. Comparators

As set out in the Issues Paper, our view is that the systematic risk of iron ore mining is relevant to the systematic risk of TPI's railway. We discuss further in this report how an efficient contract is likely to share volume risks between a railway and its customers, and how margin pressures will ultimately also be shared between the two parties.

The Authority, on the other hand, is of the view that it has not been adequately demonstrated that the systematic risk of an infrastructure business depends on the systematic risk of its customers. The Authority has therefore requested that we prepare an estimate of a WACC for an infrastructure business with the characteristics of TPI's railway.

We were unable to find any direct comparators for TPI's railway. This is because single-use railways are generally part of a larger firm, whether as part of a firm that owns and operates multiple railroads or as part of a firm that uses or produces the commodity transported. As a result, we were not able to identify any single-use railways on any stock market. There are also no firms in other industries that provide a direct comparator.

One option is to estimate the beta for an infrastructure firm based on the betas of freight railroads in Canada and the United States, and on marine ports. We have selected these firms as comparators because they are focussed on the transportation of freight. However, the large and diversified nature of the firms may mean that their betas are lower than the betas that might apply to a relatively small single-use railroad. Weighting the asset betas by total enterprise value, this suggests an asset beta of 0.69 if the debt beta is zero, and an asset beta of 0.72 if the debt beta is 0.1. Due to the much larger value of the Canadian and US freight railroads, these asset beta estimates are essentially identical to the betas of the freight railroads alone. The asset beta estimates are those that might apply to a general freight railroad such as WestNet.

Another option is to rely on the beta of Genessee & Wyoming Inc. (GWI), which owns, leases, and operates a total of 48 regional short-line railroads. GWI is the sole estimate that we have for shortline railroads, and the portfolio of railroads owned by GWI mean that it is in some ways representative of the "short line railroad" industry. GWI has an asset beta of 1.07 if the debt beta is zero, and an asset beta of 1.10 if the debt beta is 0.1. However, GWI also has considerable diversity across industries served, and across regions, so again it might not provide a particularly good comparator for TPI. In addition, the practice of relying on the eta for a single firm is usually discouraged because the high errors inherent in beta estimates mean that a single beta estimate may have significant inaccuracies.

Our view is that there is likely to be some sharing of risk between mines and an independent railway that was serving those mines. As a result the asset beta for such a railroad would lie somewhere along a continuum between the asset beta for a diversified freight railroad and the asset beta for mining. Exactly where the beta might lie is a matter of judgement. A weighted average across both infrastructure and mining-related firms provides an asset beta estimate of 0.77 if the debt beta is zero, and 0.79 if the debt beta is 0.1. These beta estimates include a correction to the beta of Australian mining firms because their betas will be biased upwards when estimated against the Australian stock market index.[1]

1.1.2. Risk-Free Rate of Return

We use the yield on benchmark 10-year Commonwealth Government Bonds as the risk-free rate of return. Consistent with the approach adopted by the Australian Energy Regulator (AER), the Victorian Essential Services Commission (ESC), and the Authority in the 2008 Freight and Urban Railways Determination,[2] we apply the average rate across the most recent 20 trading days.

The average yield on 10-year Commonwealth Government Bonds for the 20 trading days prior to 20 December 2008 was 4.369%.

1.1.3. Debt

Based on available capital market evidence, a benchmark credit rating of BBB and a debt risk premium of 295.42 basis points is recommended. For the WACC for an infrastructure firm we recommend a gearing ratio of 28%, and for a WACC based on both rail and mining firms it is appropriate to use a ratio of 32%.

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1 We note that this problem occurs whenever a firm or group of firms forms an abnormally large component of a local market. Betas can be biased upwards giving the aberrant result that an investor would require more to invest in that firm because it is listed on that local market rather than on some other market.

2 Economic Regulation Authority (2008) *2008 Weighted Average Cost of Capital for the Freight (WestNet Rail) and Urban (Public Transport Authority) Railway Networks*, Final Determination, 23 June.

1.1.4. Gamma

Gamma can be calculated as the product of (i) theta – the proportion of imputation credits distributed that can be utilised by investors – and (ii) the proportion of credits created that can be distributed.

A detailed study of all the literature relevant to the determination of gamma is beyond the scope of this report. However, our interpretation of the empirical studies is that there is support for a theta of zero and support for a theta as high as 0.57.

Anecdotal evidence suggests that foreign investors are the marginal investors in the Australian market. If this is true then there is a strong theoretical argument that the value of theta should be zero based on the notion that the marginal investor is a foreign investor who is not able to make use of imputation credits. This view is supported by a number of empirical studies which are not concerned with the specific identity of the marginal investor.

If the alternative view is taken that gamma should be calculated as a weighted average across investors, then weight should be given to Australian Tax Office statistics which show only 32% of distributed franking credits being redeemed. This suggests an upper limit for theta of 0.32.

In the absence of evidence to the contrary, it is reasonable to assume that 71% of imputation credits created are distributed. Taken together with the values for theta this suggests a range of 0 to 0.40 for gamma,[3] with Australian Tax Office statistics suggesting a value of 0.23.[4]

The behavioural test of gamma suggested by Synergies Economic Consulting (Synergies) supports the proposition that gamma is less than 0.5, but it does not necessarily imply that the value of gamma should be zero. We are of the view that their test should be run on further values of gamma to refine the possible range for gamma.

1.1.5. Debt Beta

The Authority requested that CRA prepared an estimate of the debt beta. The literature we have reviewed indicates that the debt beta is a function of the credit rating. The benchmark credit rating of BBB corresponds to a debt beta of 0.04 times the assumed equity beta with a standard deviation of 0.025. Computed against the market portfolio (which has an equity beta of 1) this suggests a beta of 0.04 within a range of 0.015 to 0.065 (one standard deviation either side of the mean). However, calculations of the WACC with a debt beta of zero and a debt beta of 0.1 indicate that the debt beta makes no material difference to the WACC. We therefore recommend that the Authority applies a debt beta of zero.

3 The upper bound is calculated as gamma = 0.57 x 0.71 = 0.4047 ≈ 0.40.

4 Gamma = 0 32 x 0.71 = 0.2272 ≈ 0.23

1.1.6. WACC Estimate

Given the parameter values above, we calculate that the post-tax nominal WACC and pre-tax real WACC for TPI as shown in Table 1 and Table 2. Table 1 shows the calculation of the WACC for a diversified freight infrastructure firm. Table 2 shows the calculation of a WACC using beta calculated as a weighted average across infrastructure and mining firms. Rather than using the point estimate of 0.04 for the debt beta, we use lower- and upper-bounds of 0 and 0.1 respectively.

For an infrastructure firm focussed on diversified freight, the point estimate for the post-tax nominal WACC with recommended parameter values is 8.74% (for debt beta of 0.1) and 8.75% (for debt beta of 0), corresponding to a pre-tax real WACC of 8.84% in both cases. If gamma is increased to 0.5, which we do not recommend, then the post-tax nominal WACC increases by 0.01%, but the pre-tax real WACC decreases to 7.96% (debt beta of 0.1) and 7.97% (debt beta of 0).

Using the weighted average asset beta across infrastructure and mining firms, we calculate a post-tax nominal WACC of 9.19% (debt beta of 0.1) and 9.21% (debt beta of 0), corresponding to a pre-tax real WACC of 9.43% and 9.46% respectively.

In all cases the debt beta makes no material difference to the WACC and any variations introduced because of the debt beta are minimal compared to the degree of uncertainty in the various parameters. We therefore recommend that the Authority applies a debt beta of zero (rather than a point estimate of 0.04).

Table 1: Calculation of an Infrastructure WACC based on Diversified Freight

		Infrastructure (Railroads & Ports)			
		Gamma = 0.23		Gamma = 0.5	
Risk free RoR	rf	4.369%	4.369%	4.369%	4.369%
Gearing	D	28%	28%	28%	28%
Debt Premium (bps)	p	295	295	295	295
Debt Issuance Costs (bps)	dic	12.5	12.5	12.5	12.5
Cost of debt	rd	7.45%	7.45%	7.45%	7.45%
Market risk premium	MRP	6.00%	6.00%	6.00%	6.00%
Corporate tax rate	T	30.0%	30.0%	30.0%	30.0%
Gamma	γ	0.23	0 23	0.5	0.5
Asset Beta	Ba	0.69	0 72	0.69	0 72
Debt Beta	Bd	0	0.1	0	0.1
	D/E	0.389	0.389	0.389	0.389
	X	0.382	0.382	0.385	0.385
Equity Beta	Be	0.96	0.96	0.96	0.96
Required Return on Equity	re	10.12%	10.12%	10.13%	10.12%
Post tax nominal WACC	w_N	8.75%	8.74%	8.76%	8.75%
Pre-tax nominal WACC		11.56%	11.56%	10.67%	10.66%
Inflation		2 50%	2.50%	2 50%	2.50%
Pre-tax real WACC	w_R	8 84%	8.84%	7 97%	7.96%

Table 2: Calculation of WACC based on Infrastructure & Mining

		Infrastructure and Mining	
Risk free RoR	*rf*	4.369%	4.369%
Gearing	*D*	32%	32%
Debt Premium (bps)	*p*	295	295
Debt Issuance Costs (bps)	*dic*	12.5	12.5
Cost of debt	*rd*	7.45%	7.45%
Market risk premium	*MRP*	6.00%	6.00%
Corporate tax rate	*T*	30.0%	30.0%
Gamma	γ	0.23	0.23
Asset Beta	*Ba*	0.77	0.79
Debt Beta	*Bd*	0	0.1
	D/E	0.471	0.471
	X	0.463	0.463
Equity Beta	*Be*	1.12	1.12
Required Return on Equity	*re*	11.09%	11.06%
Post tax nominal WACC	w_N	9.21%	9.19%
Pre-tax nominal WACC		12.19%	12.16%
Inflation		2 50%	2 50%
Pre-tax real WACC	w_R	9.46%	9.43%

1.2. COMPARISON WITH WESTNET DETERMINATION

In the 2008 Freight and Urban Railways Determination, the Authority adopted an equity beta of 1.00 for WestNet's freight business. That equity beta is not directly comparable with the equity betas in Table 1 and Table 2 because of different assumptions about gearing and the cost of debt.

Table 3 overleaf applies the parameters that we recommend to the implied asset beta of 0.655 used in the WestNet decision. These parameters provide an equity beta of 0.96 for WestNet, which should be compared with our recommended equity beta of 1.12 for the WACC based on infrastructure and mining.

Table 4 overleaf applies the parameters in the WestNet decision to the asset beta that we calculate for infrastructure and mining. The asset beta translates into an equity beta of 1.17, which is directly comparable to the equity beta of 1.00 used in the WestNet decision.

Table 3: Application of Recommended Parameters to WestNet

	WestNet	Recommended Parameters
Asset Beta	0.66	0.66
Debt Beta	-	-
Cost of Debt	9.52%	7.45%
Gearing	35%	32%
Gamma	50%	23%
Tax	30%	30%
Equity Beta	1.00	0.96

Table 4: Application of WestNet Parameters to Infrastructure & Mining

	Infrastructure & Mining	WestNet Parameters
Asset Beta	0 77	0 77
Debt Beta	-	-
Cost of Debt	7.45%	9.52%
Gearing	32%	35%
Gamma	23%	50%
Tax	30%	30%
Equity Beta	1 12	1 17

1.3. Asymmetric Risk

In the Issues Paper we reviewed the various measures suggested by TPI as potential ways to provide compensation for asymmetric risk. As we noted in the Issues Paper, a number of the options reviewed by TPI are extremely complex to implement and there is a lack of good data for developing a robust estimate.

We have reviewed the various submissions on asymmetric risk. The North-West Iron Ore Alliance (NWIOA) and the United Minerals Corporation (UMC) argued strongly that there is little risk of a large scale reduction in demand (and hence stranding), while the Australian Rail Track Corporation (ARTC) noted that there has been a drop-off in orders from some suppliers.[5] This latter point has also been reported in the press, although it

5 ARTC (2008) *Economic Regulation Authority – Issues Paper: Determination of the Weighted Average Cost of Capital for The Pilbara Infrastructure's Railway from the Cloud Break Iron Ore Mine in The Pilbara to Port Hedland*, ARTC Submission, p.3

appears to be localised to certain suppliers.[6] We are somewhat less optimistic about the future than the NWIOA or UMC. However, an economic interpretation of a supply curve produced by FMG (and submitted by NWIOA and UMC) suggests that Fortescue Metals Group's (FMG's) Pilbara operations could be largely insulated in the event of a decline in demand. This suggests that that the stranding risk for the overall TPI railway does not appear to be large.

Although stranding risk in total does not appear to be large, it is still possible that stranding risk could be material for particular parts of the TPI system, particularly in relation to parts of the network that have been constructed specifically at the request of third parties. It is reasonable, therefore, to have some means of providing compensation for, or protection against, asymmetric risk.

Suggestions were made by various parties on alternative means for compensating for asymmetric risk, with Hancock Prospecting (Hancock) and the NWIOA noting that asymmetric risk should not be compensated in the WACC if it is already allowed for elsewhere. TPI's own proposals to utilise accelerated depreciation were noted by NWIOA and UMC, as was the ability for TPI to require up-front capital contributions to help meet the cost of capacity expansions. ARTC suggests the adoption of a "loss capitalisation" approach – whereby losses over the early period of the project are capitalised – in preference to accelerated depreciation. ARTC also suggests that an increment on the WACC or selecting a value from the upper end of a range of values could understate the risks to TPI. The NWIOA noted that the railway should not be treated as a whole when assessing stranding risk – we agree with this and note that individual branch connections and capacity upgrades for a specific user are far more likely to be stranded than the mainline. The NWIOA and UMC propose an approved programme of Major Periodic Maintenance as an alternative to depreciation.

We consider the vast majority of all of these points are very valid, but it is unclear whether NWIOA's suggested treatment of Major Periodic Maintenance would provide full compensation to TPI. TPI's original submission suggested ways to increase the WACC to compensate for asymmetric risk. Our view is that the various measures suggested above provide a more robust means of dealing with asymmetric risk than the TPI proposals. The suggestions by submitters also benefit from not relying on contentious estimates of what an appropriate risk premium might be. Up-front capital contributions would eliminate stranding risk for the portion of any capacity expansion that is covered by the contribution, and accelerated depreciation would significantly reduce stranding risk for the residual.

6 On 9 October 2008 Mt Gibson Iron released a statement to the Australian Stock Exchange indicating it had been asked to postpone deliveries. However, BHP Billiton, Rio Tinto and FMG all indicated that they had not had similar problems See "China Steel Mills Slowing Ore Demand, Mt Gibson Says", Bloomberg, 9 October 2008 Available online at http://www.bloomberg.com/apps/news?pid=20601081&refer=australia&sid=acX0jM7Lgy2I.

Nevertheless, it is reasonable for TPI to require some protection against asymmetric risk. There are a range of mechanisms available for this that do not rely on contentious estimates of an additional premium, including accelerated depreciation, up-front capital contributions, alternative treatment of major periodic maintenance, etc. We recommend that the Authority uses those mechanisms to minimise asymmetric risk rather than increasing the WACC.

2. INTRODUCTION

2.1. PROJECT SCOPE

CRA was retained by the Economic Regulation Authority (Authority or ERA) to provide recommendations on the parameters to be applied in the calculation of the WACC for TPI's iron ore railway in the Pilbara. The WACC model applied should be the Officer model, as applied by the Authority in the 2008 Freight and Urban Railways Determination. The market risk premium should also be the 6% value applied in the Authority's other determinations. CRA's advice on the WACC is therefore primarily focussed on:

- Selecting appropriate comparator companies;
- Estimating the cost of debt;
- Systematic risk and calculating the cost of equity (using the assumed market risk premium); and
- Conversion of the nominal post-tax WACC to a real pre-tax WACC.

The Authority also requested CRA to provide advice on the treatment of asymmetric risk.

2.2. REPORT STRUCTURE

This report is structured as follows:

- Section 3 discusses the selection of comparator companies;
- Section 4 estimates the risk-free rate of return and the cost of debt;
- Section 5 discusses issues of taxation and dividend imputation;
- Section 6 discusses systematic risk and presents estimates of the debt beta, asset beta, and equity beta;
- Section 7 provides some brief comments on the Market Risk Premium;
- Section 8 presents the calculation of the WACC; and
- Section 9 considers the magnitude and appropriate treatment of asymmetric risk.

3. COMPARATOR COMPANIES

WACC calculation requires estimation of the company's cost of debt and equity and its gearing. For a listed company such data is available from capital markets. In cases when a company is regulated, components of its regulatory WACC are often set based on target or expected values calculated by the regulator. In the case at hand, market observations for TPI's cost of debt and equity are not available and therefore we rely on the data available for a set of comparable companies. Comparator companies, therefore, are required for establishing benchmark values for:

- the credit rating and hence the debt premium and cost of debt;
- gearing; and
- the asset beta.

Comparator companies ideally should have the same characteristics as the regulated firm, i.e. the same exposure to systematic risk, asset stranding and other asset-related risks.

The ideal comparator companies would be other railroads dedicated to carrying a single commodity, preferably a mineral that is exported. There are few companies that fit this description, so it is necessary to consider a wider set of comparators. Suitable comparators might include:

- other railroads specialising in freight services;
- other infrastructure companies, such as electricity networks, gas networks, roads, airports, and ports; and
- mining companies specialising in iron ore.

The key arguments for or against each of these types of companies centre on the exposure of each to systematic risk.

3.1. CONCEPTUAL ANALYSIS

The Nature of Contracts

TPI's exposure to systematic risk will depend on the type of contracts that it has entered. While it is possible that TPI *could* enter fixed price contracts that would largely (but not entirely) eliminate systematic risk, it is not obvious that such contracts would be commercially possible for an independent railroad nor that such contracts would be efficient.

An efficient contract allocates risk to the party best able to manage that risk. Where neither party can manage the risk, it is generally efficient to share the risk. Placing the entire quantum of an unmanageable risk on to one party increases the chance of that party judging that the risks outweigh the rewards, and hence increases the chance that an otherwise mutually beneficial (and welfare-enhancing) arrangement does not occur.

An Independent Railroad's Likely Risks

To consider the risks that TPI might be exposed to it is necessary to consider the value chain from the mine to the steel mill, consider the total risks faced by both an independent railroad owner and operator and the mine operator, and consider the likely allocation of those risks.

Key risks would seem to be:

- Reduction in demand from steel mills, thereby reducing demand for iron ore from the mine and reducing the quantity of ore transported over the railroad;
- Reduction in the price of ore, thereby reducing the attractiveness of continuing to mine for ore;
- An increase in the cost of mining;
- An increase in the cost of operating the railroad; and
- An increase in the cost of shipping, whether due to fuel prices, shortage of ships, or increased insurance premiums.

We would expect that there would be a volume component to the charge structure negotiated by an independent railroad. This would have the effect of sharing the demand risk that cannot be controlled by either party. The costs of the mine operator are likely to be more responsive to volume than are the costs of maintaining and operating a track network, so we would expect that the mine operator would bear the greater portion of the demand risk.

In the first instance an increase in the cost of mining would be borne by the mine operator, and an increase in the cost of operating the railroad would be borne by the railroad operator. However, the railroad operator is likely to be able to pass on at least a portion of increased costs when rates are renegotiated.

We also note that many of these items impact on the profitability of the mine operator and could ultimately squeeze margins to the point where operator has to consider whether to continue mining. Such decisions may have seemed unlikely given the extremely buoyant market for iron ore in recent years, but now appear more likely given the recent downturn in the iron ore market. When adverse conditions do occur we would expect downwards pressure to be placed on the rates charged by an independent railroad, i.e. the railroad operator ultimately shares part of the costs faced by the mining operator. This would be accentuated where the independent railroad was parallel to a potentially competing railroad.

In summary, it seems likely that an independent railroad operator would be exposed to both volume risk and price risk, with both of those risks reflecting the demand and profit risks faced by the mine operator. This implies that mining companies may provide an appropriate comparator for the independent single-commodity railroad hauling minerals.

3.2. Other Infrastructure Companies

The range of potentially relevant infrastructure companies includes railroads specialising in freight services, as well as electricity networks, gas networks, roads, airports, and ports. A common feature of all of these types of companies is that they have a diversified customer base, and hence risks will also be more diversified. To the extent that mining companies have a higher systematic risk than the general economy this means that infrastructure companies will have a lower systematic risk than mining companies. Diversified infrastructure companies, therefore, are not good comparators for TPI.

Some infrastructure companies would not be suitable comparators because of the way that they are regulated. Any firm with a regulated revenue cap and an overs-and-unders account is likely to have lower levels of systematic risk than we would expect from an independent single-commodity railroad. We therefore consider that electricity and gas networks are likely to provide relatively poor comparators for railway infrastructure.

On the other hand, companies that specialise in freight transportation, and particularly freight transportation by rail, are more likely to be subject to similar systematic risks as TPI. As discussed above, firms specialised in mining of iron ore or mining services are also likely to be faced with similar systematic risks. We therefore include these firms as comparators for TPI in our analysis of the applicable debt and equity betas and the determination of an applicable credit rating for TPI.

Other potential comparators include airports, ports, and roads. We consider that airports and roads would be poor comparators: in particular, they have a significant component of passenger transportation, so are unlikely to reflect the risks associated with freight transportation.[7] Marine ports, on the other hand, are primarily concerned with freight, and so may provide suitable comparators.

3.3. Comparators

Based on the factors discussed above, the companies that we have selected as comparators are set out in Table 5 overleaf. Short descriptions for each of these companies are provided in Appendix A.

7 We note that ACG (2007) used toll roads as a comparator for the passenger network, but not for the freight network.

Table 5: Comparator Companies

Industry	Country	Company
Freight Railroads	United States	Kansas City Southern
	United States	Genesee & Wyoming Inc.
	United States	CSX Corp.
	United States	Union Pacific Corp.
	United States	Norfolk Southern Corp.
	United States	Burlington Northern Santa Fe Corp.
	Canada	Canadian Pacific Railway Limited
	Canada	Canadian National Railway Company
Marine Ports	Europe	Eurokai KGaA
	United Kingdom	Forth Ports plc
	Europe	Royal Vopak NV
	New Zealand	Port of Tauranga Ltd
	New Zealand	Lyttelton Port Co. Ltd.
Mining Services	Australia	Orica Ltd
Diversified Minerals	Australia	BHP Billiton Ltd
	Australia	Rio Tinto Ltd
	Australia	Oxiana Ltd
Iron Ores	United States	United States Steel Corp.
	United States	Cliffs Natural Resources Inc.
	Australia	Fortescue Metals Group Ltd.
	Australia	Mount Gibson Iron Ltd.
	Australia	Ferrowest Limited
	Australia	Territory Resources Limited
	Australia	OneSteel Ltd

4. THE RISK-FREE RATE OF RETURN AND THE COST OF DEBT

The cost of debt is calculated as the sum of the risk-free rate of return, the estimated debt premium, and the estimated debt issuance costs.

4.1. RISK-FREE RATE OF RETURN

We use the yield on benchmark 10-year Commonwealth Government Bonds as the risk-free rate of return. Consistent with the approach adopted by the AER, the Victorian Essential Services Commission, and the Authority in the 2008 Freight and Urban Railways Determination, we apply the average rate across the most recent 20 trading days.

The average yield on 10-year Commonwealth Government Bonds for the 20 trading days ending 19 December 2008 was 4.369%.

In order to calculate the hypothetical cost of debt of a marginal investor, it is important to match the maturities of the benchmark risk-free rate with the suggested spread above the risk-free rate. Therefore, we rely on 10-year spreads over the benchmark rate to match the Authority's choice of the risk-free rate.

4.2. BENCHMARK CREDIT RATING AND GEARING

There is likely to be a general relationship between credit rating and gearing within any given industry. All else being equal, higher gearing is associated with higher risk for the bond holders, so increasing gearing is likely to be associated with decreasing credit rating. Establishing a benchmark credit rating from one data set and a benchmark gearing ratio from a second data set raises the risk that the two benchmarks will be inconsistent. For that reason we consider that it is appropriate to establish the benchmark credit rating and benchmark gearing simultaneously.

It should be noted that a large number of potential comparator firms for TPI either did not have significant debt outstanding or did not have any credit rating data available for them on either Bloomberg or Capital IQ. Table 6 provides a subset of potential comparator firms for which ratings could be found. On a debt-weighted basis, on average these firms had BBB (or equivalent) credit ratings. The average ratio of debt to total enterprise value is 28% for the freight railroads, 34% for the mining related firms, and 32% across all firms.

For a WACC based solely on the freight railroad estimates it is therefore appropriate to use a ratio of 28%, and for a WACC based on both rail and mining firms it is appropriate to use a ratio of 32%.

Table 6: Credit rating of comparable to TPI firms

Company Name	Industry Name	Market	Fitch LT Issuer	Fitch ST Issuer	Moody's Issuer	S&P LT Local currency Issuer Credit	S&P LT Issuer Foreign Currency Credit	Market Cap ($M)	Total Enterprise Value ($M)	Total Debt ($M)	Net Debt ($M)	Total Debt/EV
Burlington Northern	Railroad	US			Baa1	BBB	BBB	25,887	34,111	8,700	8,224	26%
Can. National Railway	Railroad	US			A3	A-	A-	16,473	21,739	5,502	5,266	25%
CSX Corp.	Railroad	US	BBB-	WD	Baa3	BBB-	BBB-	14,438	21,377	7,910	6,939	37%
Norfolk Southern	Railroad	US	BBB+	F2	Baa1	BBB+	BBB+	17,903	23,950	6,604		28%
Union Pacific	Railroad	US			Baa2	BBB	BBB	25,332	32,937	8,462		26%
Orica Ltd	Mining Services	AU				BBB+	BBB+	3,404	4,126	660		16%
BHP Billiton Ltd	Diversified Minerals	AU				A+	A+	98,015	104,209	12,680		12%
Rio Tinto Ltd	Diversified Minerals	AU	A- *+	F2 *+		BBB+ *	BBB+ *	34,863	64,144	43,879	41,422	68%
Oxiana Ltd	Diversified Minerals	AU	BBB-					1,059	1,507	487	420	32%
United States Steel Corp.	Iron ores	AU				BB+	BB+	3,383	5,971	2,588		43%
Fortescue Metals Group Ltd.	Iron ores	AU				B+		2,472	6,446	3,974		62%

Source: Capital IQ (accessed 26 November 2008) and Bloomberg.

4.3. Debt Premium

We calculate the debt premium as the average premium for 10-year corporate bonds at a benchmark credit rating over the yield on 10-year Commonwealth Government bonds. The premium would ideally be based on observed premia. However, there are so few 10-year corporate bonds issued in Australia that it is necessary to either rely on a prediction model or to apply the premium for the closest benchmark reported by a source such as Bloomberg.

For the 2008 Freight and Urban Railways Determination the Allen Consulting Group (ACG) utilised the predictions generated by Bloomberg and by CBA Spectrum, and adjusted those predictions to reflect average differences compared with actual data.[8]

An alternative approach used by the Victorian Essential Services Commission is to apply the premium for benchmark Australian corporate 8-year bonds.

It is also possible to draw conclusions from the levels of spreads internationally and not just in Australia. The information available for bonds issued in Australia and in the US is evaluated in the following section.

4.3.1. Adjustment for Default Risk

In the Issues Paper we also raised the question of whether any adjustments should be made for credit or default risk. Synergies commented that:[9]

> *"the CAPM is a long-term forward-looking model used to estimate returns required to compensate debt and equity holders for investing in the business. As such, it is only ex-ante returns that are of interest to investors. It is inconsistent with generally accepted modern financial theory to discount such forward looking estimates on the basis of historic realised returns".*

Our view is that expected returns should be discounted using the expected rate of return, and promised returns should be discounted using the promised rate of return. We also note that the estimated cost of equity uses historical calculations of realised returns to calculate an estimate of the expected cost of equity,[10] and such an approach is also adopted by Synergies.[11]

8 ACG (2007) *Railways (Access) Code 2000: Weighted Average Cost of Capital, 2008 WACC Determinations*, Report to the Economic Regulation Authority, October, pp. 20-21.

9 Synergies (2008) *The Pilbara Infrastructure Pty Ltd, Review of the Weighted Average Cost of Capital*, October, p. 32.

10 We note in particular that the MRP is an estimate of the historic realised returns on the market portfolio, expressed as a premium over the risk-free rate of return.

11 Synergies (2008) p 39 states "While acknowledging the conceptual correctness of a forward-looking method to estimate MRP, we are not of the view that survey results should be used to derive estimates of MRP We have therefore focussed on estimates produced using historical averaging".

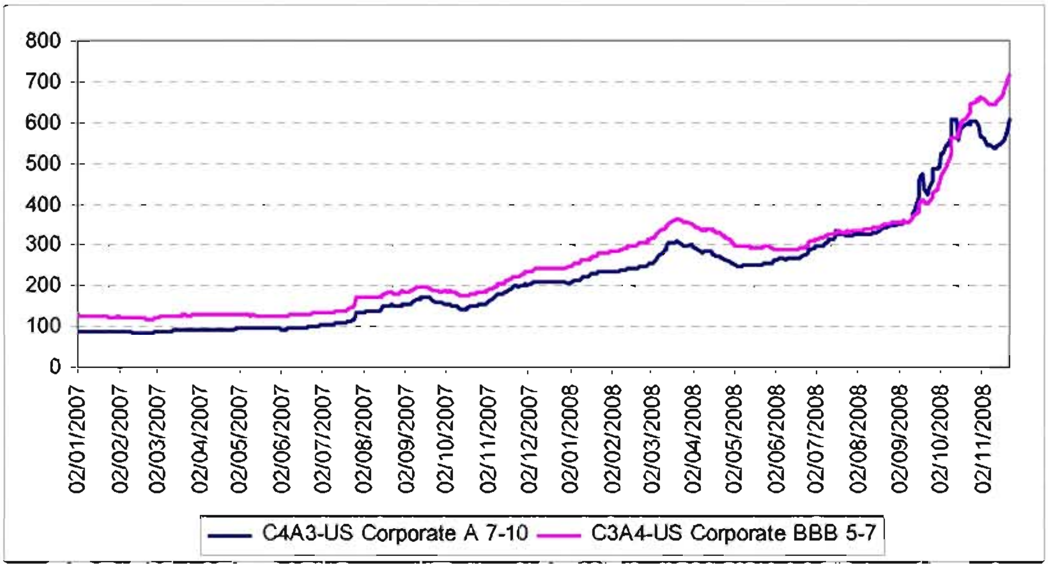
There is a question whether it is inconsistent to adopt an average of an expected equity return and a promised debt return when calculating a WACC used for regulatory purposes. To the extent that the WACC is used to set maximum revenues or returns, then it may even be appropriate to adjust the cost of equity upwards so that expected revenues – which will be less than the maximum – provide the expected return. Alternatively, if the WACC is used to set what genuinely is an "expected" earnings path, with opportunities to earn both above and below that level then an expected WACC is appropriate, which implies both an expected cost of debt and an expected cost of equity.

Nevertheless, we note that the use of an expected equity return and a promised debt return is the commonly adopted approach, and is accepted by both the Authority and submitters. The cost of debt calculated on this basis reflects the cost paid by the benchmark firm if it was issuing debt at the date of the determination, rather than the expected return to holders of that debt. This is consistent with the view that the purpose of the regulatory WACC is to compensate the *firm* for its capital costs.

4.3.2. Spreads of BBB-rated Australian and US firms over benchmark government rates

As Figure 1 below shows, spreads on A and BBB-rated US bonds have widened substantially since the beginning of the credit crunch in mid-2007 and are currently are above 700 basis points. This is a 600-basis point change since before the crisis when spreads were closer to 100-150 basis points.

Figure 1: Spreads for A and BBB-rated corporate US bonds with maturities of 7-10 years (spread over benchmark risk-free rate, basis points)

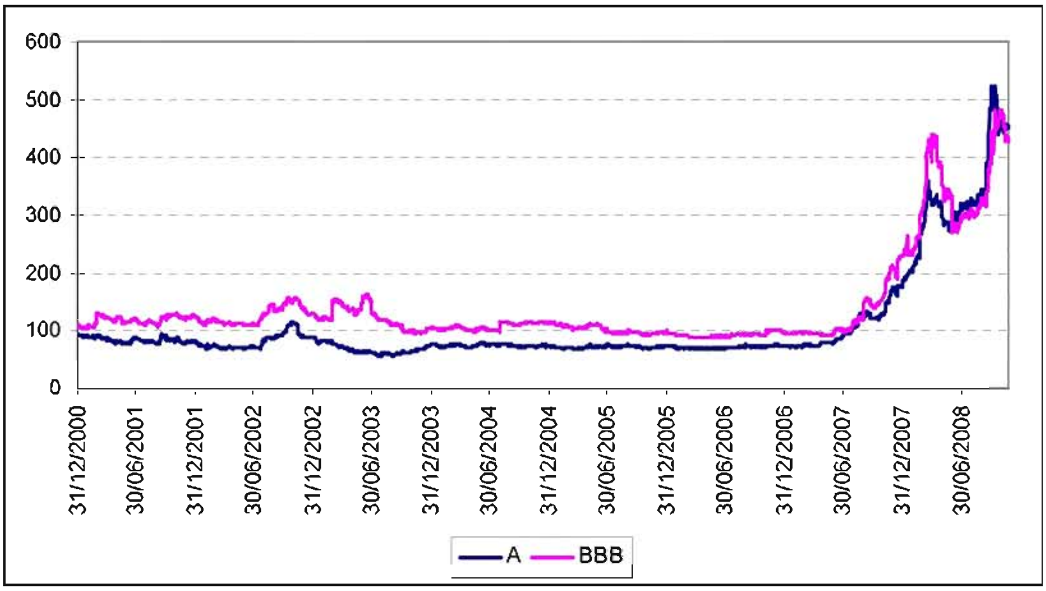


Source: Bloomberg, ML C4A3 and C4A4 indices

While reliance on spreads for a given credit rating provides a good approximation for an average cost of debt for a firm with this credit rating, it should be kept in mind that there is a substantial amount of variability even within a given credit. For example, for BBB-rated 7-10 year US corporate bonds (on 26 November 2008), Bloomberg data shows that25% had spreads of between 500 and 550 bps, with a range from 169 to 6825 bps.

Given that there are not as many bonds issued in the Australian market, an index of Australian bonds by credit rating combines all bonds regardless of their maturity. The index for A-rated bonds contains 54 bonds (with duration of slightly over 3 years) and the index for BBB-rated bonds contains 22 issues (with duration of 2.5 years).[12] The spreads on these bonds over Australian benchmark treasury rates are lower than those for the US corporate rates. Some of this, however, could be explained by the difference in maturities.

Figure 2: Spreads on A and BBB rated Australian bonds (spread, basis points)

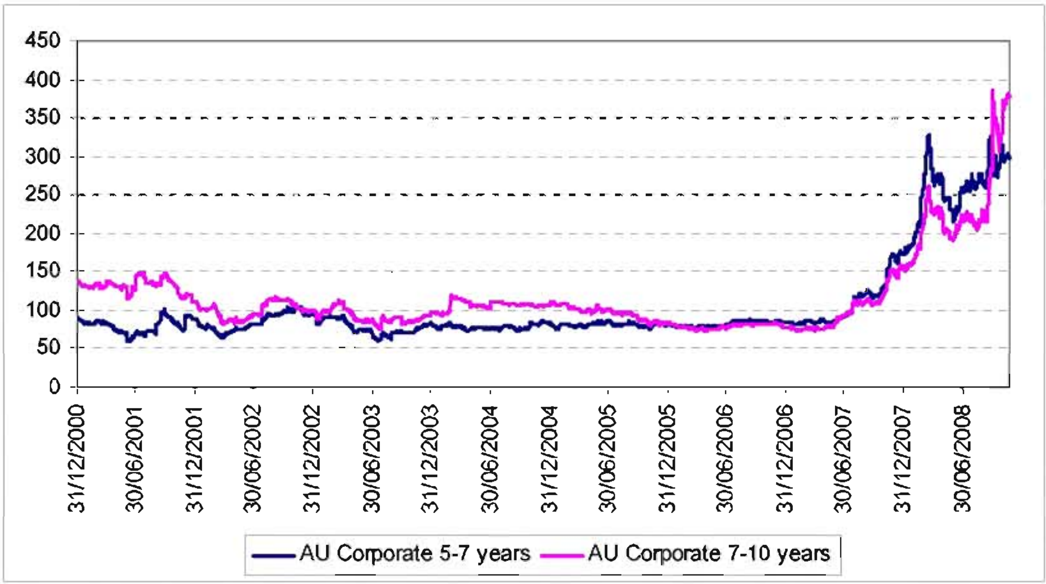


Source: Bloomberg, ML AC30 and AC40.

The next chart shows spreads on Australian bonds by maturity against the benchmark treasury rate. The spreads for bonds with longer maturity are in the order of 350-400 basis points, about 250 basis points below BBB-rated US corporate bonds.

12 The duration of a bond is the weighted average time to receipt of the cash flows, with the weights being the NPV of each cash flow. A bond with coupon payments therefore has a duration that is less than its tenor.

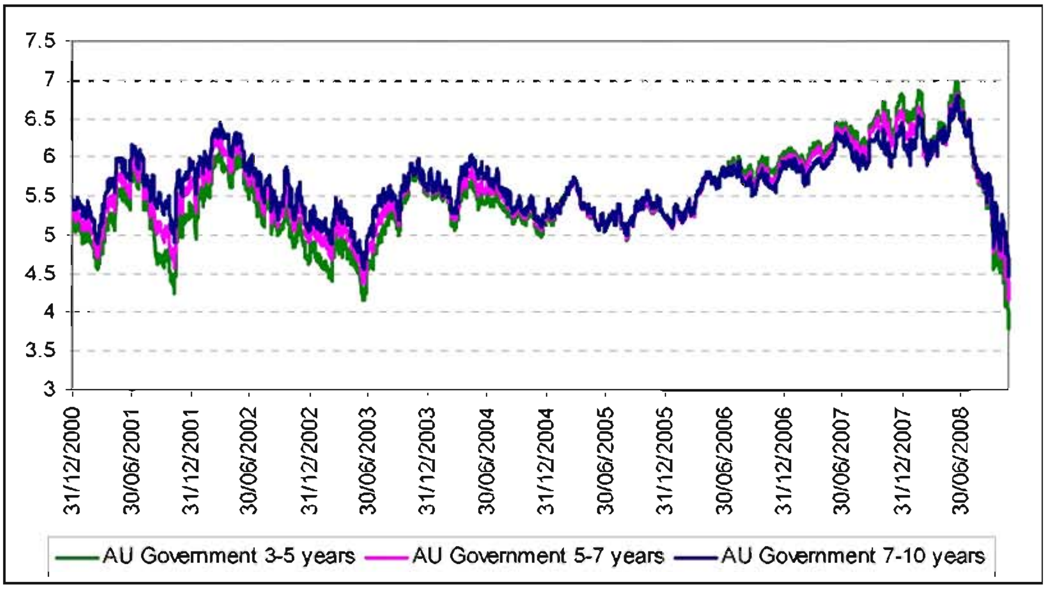
Figure 3: Spreads on 5-7 and 7-10-year Australian bonds (spread, basis points)



Source. Bloomberg, ML AUC3 and AUC4.

It should be noted that some of the recent widening of the spread is driven by the "flight to safety" by capital investors. This has resulted in a decrease in yields of government issued bonds in both Australia (Figure 4) and the US.

Figure 4: 3-5, 5-7 and 7-10-year Australian Treasury benchmark (yield, %)



Source: Bloomberg

4.3.3. Spreads on Benchmark Bonds

Bloomberg discontinued the 10-year BBB Corporate index for Australia in March 2008 due to insufficient issues, so it is not possible to directly observe the spread between a benchmark 10 year BBB Corporate bond index and the benchmark 10 year Commonwealth Bond.

However, it is possible to obtain information for the 10-year A-rated bond spread over the benchmark government 10-year bond from Bloomberg together with 8-year A and BBB-rated indices for Australian corporate bonds. Using this data the spread for a 10 year BBB-rated Corporate bond can be approximated using the following formula:

$$Spread = (8-\text{year BBB Corporate} - 8-\text{year A Corporate}) + (10-\text{year BBB Corporate} - 10-\text{year Government benchmark})$$

From the data available on Bloomberg, the average over the 20 trading days to 19 December 2008 was:

- 5.87bps for the spread between BBB and A-rated corporate 8 year Australian corporate bonds; and
- 289.56 bps for the spread between A-rated 10-year Australian corporate bonds and the benchmark 10-year Australian government bonds.

Adding these two spreads together, we arrive at an average spread of 295.42bps.

It should be noted that comparably rated bonds in the US seem to have higher spreads for both A and BBB-rated bonds of similar maturity. We use the approach recommended by the Authority and use 295.42bps as the debt premium above risk-free rate for TPI's hypothetical cost of debt.

4.4. Debt Issuance Costs

Debt issuance costs including a variety of fees involved in raising debt finance, such as underwriting fees, legal fees, and the costs associated with obtaining a credit rating. These costs are not reflected in the price of traded debt, but they are a cost that is borne by the company. Ultimately, a benchmark firm operating in a competitive market (where all firms bear these costs) would have higher prices in order to recover these costs. It is therefore appropriate to make an allowance for debt issuance costs.

For the 2008 Freight and Urban Railways Determination, ACG recommended that the Authority adopt an allowance for debt issuance costs of 12.5bp. The Authority also adopted this value in its final determination.[13]

Hancock supports the use of 12.5 bps as a benchmark measure of cost of debt raising costs (as used in standard practice by regulators in Australia). ARTC "considers an assumption of 12.5 is appropriate" (due to this allowance being consistently applied in regulatory decisions). Synergies also considers that 12.5 bps is appropriate as an estimate of the ongoing costs of debt funding.

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13 ERA (2008),p 36.

Synergies notes that Dalrymple Bay Coal Terminal (DBCT) was granted an additional premium by the QCA in recognition of additional up-front debt-raising costs, and also notes ACG's September 2004 finding that in addition to up front financing fees there is typically a commitment fee payable of between 30% and 40% of the debt margin.[14] Synergies translates this fee to an additional allowance of 1%, but does not include that 1% in their estimate of the WACC.

Our view is that it is appropriate to include an allowance for initial debt raising costs for the TPI railway. These could be included either as a mark-up on the cost of debt, as a cash-flow item, or capitalised into the asset base. In our view there is a reasonable argument to be made for capitalising the initial debt raising costs, as these are (a) costs that had to be incurred to be able to construct the railway, and (b) are costs incurred for the provision of the railway over a long time horizon.

It is therefore appropriate to include an allowance of 12.5bps for debt raising costs as part of the cost of debt.

4.5. Conclusions on Cost of Debt

Based on the discussion above, CRA recommends the parameters in Table 7 for calculating the cost of debt.

Table 7: Calculation of the Cost of Debt

Risk free RoR	rf	4.369%
Debt Premium (bps)	p	295.42
Debt Issuance Costs (bps)	dic	12.5
Cost of debt	rd	7.45%

14 ACG (2004) *Dalrymple Bay Coal Terminal: Financing Costs*, Report to Queensland Competition Authority, September p. 15.

5. TAXATION AND DIVIDEND IMPUTATION

5.1. Tax Rate

The Monkhouse formula requires the use of an effective tax rate for levering and delivering betas, and the Officer formula for the post-tax nominal WACC requires the use of a tax rate for calculating the post-tax cost of debt.

The appropriate tax rate for calculating the post-tax cost of debt is the statutory corporate tax rate, which is 30%.

As we show in Section 6.2.3 below, the precise value of the tax rate used for levering and de-levering the beta does not have a material impact. We therefore also apply the statutory corporate tax for calculating the equity beta.

5.2. Gamma

The parameter gamma captures the value of dividend imputation credits (or franking credits) to investors. Gamma has a significant impact on the cost of equity in the Officer formulation of the WACC, and as such has proved to be a very contentious parameter.

Submitters to the current review are divided on the appropriate value for gamma. Potential users of the TPI railway argue for a value of at least 0.5, while ARTC and TPI argue for a value of zero based on studies of the ability for foreign investors to utilise dividend imputation credits.

Gamma can be defined as the product of (i) the value of imputation credits distributed as a proportion of their face value – also known as the utilisation rate or theta (θ) – and (ii) the proportion of credits created that can be distributed.

5.2.1. The Victorian Gas Access Arrangement Review

ACG's October 2007 report briefly surveyed some of the arguments around gamma, focussing on the (then draft) Victorian ESC's Gas Access Arrangement Review.[15] The ESC's review contained a very detailed review of gamma, considering a range of expert reports including several by the Strategic Finance Group (SFG) submitted by the distributors,[16,17] and a report by Lally submitted by the Energy Users Association of Australia.[18] The ESC's draft report criticised certain assumptions and studies relied on by SFG. SFG responded to these criticisms and also identified a number of flaws in analysis

15 ESC (2007) *Gas Access Arrangement Review 2008-2012*, Draft Decision, 28 August.

16 SFG (2007a) *The impact of franking credits in the corporate cost of capital: Empirical evidence*, Report prepared for Envestra, 22 March

17 SFG (2007b) *Internal consistency in regulatory estimates of the value of franking credits*, Report prepared for Envestra, 22 March

18 Lally, M. (2007) "Review of parameters in the national electricity rules", Victoria University Wellington, 11 September.

relied on by the ESC.[19] In its final decision the ESC again criticised SFG analysis and demonstrated a clear preference for Lally's analysis, without subjecting Lally's analysis to the same level of scrutiny.[20]

We do not believe that the ESC's criticisms were warranted, and have strong sympathies for some of the arguments advanced by SFG.

5.2.2. The Value of θ

Taxation Regime Changes and the Value of θ

An issue of considerable importance in the ESC's draft decision was the July 2000 tax change, which allowed Australian residents who previously could not fully utilise imputation credits received to receive a cash rebate. The ESC claimed that key studies relied on by SFG predated the change and hence should be disregarded. In its report submitted to the current review, Synergies has countered this criticism by clearly identifying studies that post-date the July 2000 change.

We do not intend to review the relevant studies in detail, as that has been performed adequately by Synergies. Results of the studies are summarised in Synergies' Table 9.[21] We also note that Synergies' review (and table) includes the studies preferred by the ESC.

In our view the studies indicate the following:

- When the regulatory precedent of gamma = 0.5 was first established studies suggested a significant positive value for theta;
- After the introduction of the 45-day rule in 1997 the evidence for theta was mixed, with some studies suggesting a value for theta of zero and others suggesting a value of around 0.5;
- After the July 2000 imputation rebate change the studies remain ambiguous with Beggs and Skeels (2005) suggesting a value of 0.57, and Feuerhadt, Gray and Hall (2007) suggesting a value of zero.

The empirical evidence is therefore mixed, and does not provide unambiguous support for a value of 0.5.

The Marginal Investor Sets the Price

It is sometimes claimed that the value of gamma should be set by taking a weighted average across investors. This argument claims that because investors are collectively setting the price of the portfolio of all assets then it is the weighted average value of gamma across all investors that is relevant.

19 SFG (2008) "Essential Services Commission Final Decision – Gas Access Arrangement review 2008-12, Issues in relation to estimation of gamma", 28 March

20 ESC (2008) *Gas Access Arrangement Review 2008-2012*, Final Decision – Public Version, 7 March. For the discussion of gamma see pp. 492-509.

21 Synergies (2008), pp 60-61

If there are no clientele effects then in our view this argument lacks theoretical justification. Prices are always set by the marginal participant. In financial markets that participant is the marginal investor. If the market return was somehow set as an average across the return required by all investors, then the market return would be too low for some investors. Those investors would reduce the price that they were willing to pay for the asset, and the market price of the asset would fall until the market return was equal to the return required by the marginal investor.

It could be argued, however, that there are clientele effects which mean that different investors (or different groups of investors) are the marginal investor for different sectors of the market. Foreign investors may, for example, be the marginal investor for industrial and utility stocks, while domestic investors may be the marginal investor for retailers. If this was true then gamma would be different for different sectors of the market. Even in this scenario, gamma for the market as a whole would not be a weighted average across all investors, but would be the weighted average across the different groups of marginal investors.

The Identity of the Price-Setting (Marginal) Investor

The sharp fall in the Australian share market as foreign investors have repatriated their capital provides a very stark illustration that foreign investors are the marginal investors in the Australian stock market. Economic theory tells us that it is the marginal participant who sets the price in a market, which quite clearly suggests that theta should be set to reflect the ability of foreign investors to utilise imputation credits (i.e. theta should be set to zero). This is consistent with a number of studies.

Foreign Investors Should be Included in the Calculation of θ

Identifying foreign investors as the marginal investor sometimes raises the objection that the CAPM being estimated is a domestic CAPM and as such there should be no foreign investors (and hence theta should be set to 1). We do not agree with this objection. The Australian stock market is part of a partially-integrated international financial system in which both domestic and foreign investors participate. The estimates for the risk-free rate and the debt premium are both derived from actual data observed from that partially-integrated system. The estimate for the market risk premium is also intended to be an estimate of the appropriate premium for the Australian market within that partially-integrated system. There is no argument that any of those parameters should be estimated as if the Australian market were completely segregated from the rest of the world. Estimation of gamma should proceed on a consistent basis with the estimation of the other parameters, i.e. it should be derived from actual data.[22] This means that any argument that theta should equal 1 should be dismissed.

22 We note that the Victorian ESC also considered that the value of gamma should be estimated on a basis consistent with the degree of market integration assumed in the estimation of other parameters See ESC (2007) p 424.

A Possible Approach to Setting θ

Synergies notes Australian Tax Office statistics that only 32% of distributed franking credits were redeemed in the 2002-03 tax year. If this proportion is representative of other years, then this could set a ceiling of 32% on theta. This ceiling would apply if it is correct to treat gamma as a weighted average across all investors rather than as the value that applies to the marginal (price-setting investor).

5.2.3. Proportion of Credits that are Distributed

The second parameter used in the calculation of gamma is the proportion of imputation credits that are distributed. As noted by the Victorian ESC, Hathaway and Officer (2004) found that 71% of the imputation credits created over the period between 1988 and 2002 were distributed to shareholders.[23] The Victorian ESC considered that this proportion is too low for energy utilities, instead considering that 100% of the imputation credits created would be distributed because of their high dividend payout rate.

Without detailed financial modelling it is difficult to establish the level of imputation credits that would be paid out by a stand-alone railway in the position of TPI. Our view is that in the absence of contrary evidence there is no reason to believe that an independent railway would have a high dividend payout rate, and hence no reason to assume anything other than the market average of 71% of imputation credits created are distributed to shareholders.

5.2.4. Synergies' Behavioural Test of Gamma

Synergies describes a test that they have performed on the behaviour of price movements for unfranked and fully-franked dividends.[24] Specifically, they test whether the market responds differently to franked and unfranked dividends but comparing the relative price change of pairs of observations. Subject to the caveat that we have not reviewed their data or calculations, and nor has the study been published in a peer-reviewed journal, we are of the view that the study does support the proposition that the market values franking credits at some value less than 0.5. As Synergies reports its study, the analysis rejects the hypothesis that gamma is 1 or 0.5, and is unable to reject the hypothesis that gamma is zero.

23 Hathaway, N. and R. Officer (2004) *The Value of Imputation Tax Credits*, Capital Research Pty Ltd, 2 November.

24 Synergies (2008), pp 61-64

Synergies results do not mean that the only supportable value for gamma is zero. Instead, it is likely that there are positive values of gamma between 0 and 0.5 that would not be rejected by Synergies' test. We would like to see the study repeated at gamma values of 0.1, 0.2, 0.3, and 0.4, and then further refined to obtain the upper bound for gamma. We would also like to see the study repeated (a) with the unfranked dividends compared with different random sets of franked dividends,[25] and (b) between random pairs of franked dividends.[26] These two extensions would help to confirm the robustness of the results obtained by Synergies.

5.2.5. Conclusion

Gamma can be calculated as the product of (i) theta – the proportion of imputation credits distributed that can be utilised by investors – and (ii) the proportion of credits created that can be distributed.

A detailed study of all the literature relevant to the determination of gamma is beyond the scope of this report. However, our interpretation of the empirical studies is that there is support for a theta of zero and support for a theta as high as 0.57.

Anecdotal evidence suggests that foreign investors are the marginal investors in the Australian market. If this is true then there is a strong theoretical argument that the value of theta should be zero based on the notion that the marginal investor is a foreign investor who is not able to make use of imputation credits. As noted by Synergies, this view is supported by a number of empirical studies which are not concerned with the specific identity of the marginal investor.

If the alternative view is taken that gamma should be calculated as a weighted average across investors, then weight should be given to Australian Tax Office statistics which show only 32% of distributed franking credits being redeemed. This suggests an upper limit for theta of 0.32.

In the absence of evidence to the contrary, it is reasonable to assume that 71% of imputation credits created are distributed. Taken together with the values for theta this suggests a range of 0 to 0.40 for gamma,[27] with the Australian Tax Office statistics suggesting a value of 0.23.[28]

Synergies' behavioural test of gamma supports the proposition that gamma is less than 0.5, but it does not necessarily imply that the value of gamma should be zero.

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25 As far as we are aware, Synergies has performed the analysis with a single set of randomly selected franked dividends matched with the set of unfranked dividends. The study could be repeated with different sets of randomly selected franked dividends. If the results are robust then there would be no significant difference in results obtained with the different sets of franked dividends.

26 Pairing one randomly selected set of franked dividends with a second randomly selected set should always produce the result that the market does not treat the two sets differently.

27 The upper bound is calculated as gamma = $0.57 \times 0.71 = 0.4047 \approx 0.40$.

28 Gamma = $0.32 \times 0.71 = 0.2272 \approx 0.23$

6. SYSTEMATIC RISK

6.1. DEBT BETA

In a departure from the approach adopted in the 2008 general rail determination, the Authority has requested that CRA determine the likely range for the debt beta.

While there are difficulties in estimating debt betas, some recent academic studies have attempted to provide a framework for debt betas quantification that is consistent with the data and the theory. In particular a recent study by Stephen Schaefer and Ilya Strebulaev (Schaefer and Strebulaev, 2007)[29] estimates debt betas using a structural model framework[30] and regression analysis.

Using a large sample of bonds issued by US non-financial corporations this study estimates debt betas for a range of credit ratings. The study also confirms that on average both leverage and equity volatilities are higher for bonds with lower ratings. For example on average issues of bonds rated AAA-A have leverage of 10-32% and equity volatility of 25-31% while issues of junk bonds have average leverage ratios in the 50%(BB) to 60%(B) range and equity volatility between 49% and 69%.

Schaefer and Strebulaev (2007) estimate debt betas using the following regression:

$$r_{j,t}^{B} = \alpha_0 + \alpha_E r_{j,t}^{E} + \alpha_{r_f} r_t^{T} + e_{jt},$$

where $r_{j,t}^{B}$ is the one-month return (in excess of the one-month risk-free rate) on a (corporate) bond issued by company *j*, $r_{j,t}^{E}$ is the corresponding excess return on firm *j's* equity and r_t^{T} is the corresponding excess retum on a 10-year Treasury bond. One important difference between this regression and a conventional beta regression is the presence of the Treasury return. Schaefer and Strebulaev show that despite the presence of the Treasury return the coefficient on the firm's equity does indeed measure a bond's elasticity with respect to equity[31] and this is what is required to link the bond's risk premium to the risk premium on equity.

The results of the regressions are given in Table 8, which shows the average value of the coefficients by credit rating. The debt betas are obtained by multiplying the row labelled α_E by 100. This means, for example, that the average value of the debt beta for bonds with a BBB rating is 0.04. It should be noted that the estimated debt betas increase as

29 Stephen Schaefer and Ilya Strebulaev (2007), Structural Models of Credit Risk are Useful: Evidence form Hedge ratios on Corporate Bonds", *Journal of Financial Economics* (forthcoming).

30 The term "structural" refers to an approach in which the behaviour of credit spreads is modelled in terms of the risk and value of the assets that collateralise the debt. It is also worth adding that the main objective of the study was to investigate whether a simple structural model of credit risk could explain the debt betas that can be observed empirically. Schaefer and Strebulaev's results are quite significant as their estimated betas are not only consistent with the data but also are supported by finance theory.

31 The bond's elasticity with respect to equity measures the percentage change in the bond price for a one percent movement in the equity price. A conventional equity beta measures the elasticity of the price of equity with respect to the market

one moves from high to low quality bonds: the beta for AA bonds is around 0.01 and for BB bonds is around 0.08. Another relatively recent study has come to very similar estimates.[32]

Table 8: Estimates of debt betas by credit rating[33]

	All	AAA	AA	A	BBB	BB	B
α_0	0.02	0.02	0.01	-0.00	0.00	0.07	0 79
	(0.69)	(0.60)	(0 47)	(-0 01)	(0.05)	(1 08)	(2.98)
α_{rf}	49.59	57.29	54.65	53.25	50.33	29.36	-8.70
	(34.40)	(32.71)	(45.76)	(42.64)	(26.19)	(9.28)	(-0.73)
α_E	3.79	0.61	1.17	3.16	4.00	8.27	15.22
	(14.84)	(1.14)	(3.94)	(12.07)	(13.00)	(18.18)	(15.02)
βd	0.04	0.01	0.01	0.03	0.04	0.08	0.15
$\overline{R}^2$	0.51	0.66	0.63	0.55	0.48	0.34	0.35
N	46.84	57.30	53 28	45.23	47.60	45 03	37.86
	(1360)	(23)	(126)	(620)	(466)	(101)	(22)

Source. Schaefer and Strebulaev (2007), Table IV. *t*-statistics are in parentheses.

Another important point that Schaefer and Strebulaev mention in their study is that debt betas obtained from regressions on *individual* bonds are very imprecise. Schaefer and Strebulaev, however, achieve a good level of precision in their paper for *average* debt betas by averaging over a large number of bonds. For BBB bonds the standard error of the *average* debt beta is approximately 0.006. Table VIII of Schaefer and Strebulaev study shows estimates of the cross-sectional standard deviation of debt betas estimated from the Merton model. For BBB the cross-sectional standard deviation of debt betas is 0.042; however, at least some of this variation is likely to be the result of estimation error in asset volatility. Taking into account the average values for debt betas in adjacent credit ratings – 0.03 for "A" and 0.08 for "BB"[34] – a standard error of 0.025 seems reasonable.

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32 See Vasant Naik, Minh Trinh, Srivaths Balakrishnan and Saurav Sen (2003), "Hedging Debt with Equity", Lehman Brothers, Fixed Income, Quantitative Credit Research, November 2003

33 It is important to note that these debt betas are estimated are against the underlying equity of the firm rather than the market portfolio. However, all that is required to convert these betas to conventional betas (against the market) is to multiply them by the firm's equity beta.

34 See Table 8 above.

In summary, therefore, if the benchmark firm would be able to achieve a credit rating of BBB, in computing the WACC for TPI CRA recommends using a debt beta of 0.04 with a standard deviation of 0.025, which suggests a range of 0.015 to 0.065 (one standard deviation either side of the mean). To test whether a debt beta of this magnitude has any material impact on the WACC we use a lower bound for the debt beta of 0 and an upper bound of 0.1.

6.2. Asset Beta

Estimates of the asset beta are dependent on the debt beta assumption utilised. We therefore provide two estimates: one with the low debt beta assumption and one with the high debt beta assumption. It is not correct to use estimates of the asset beta that have been calculated with a debt beta of zero and then re-lever those estimates using a positive debt beta – doing so will artificially lower the calculated equity beta and cost of equity.

6.2.1. Comments in Submissions

There was generally little comment on the beta that should be employed for the TPI railway. Hancock supports the use of QRs coal network as a suitable comparator as the nature of the traffic means that QR's network embodies similar systematic risk characteristics to TPIs railway. ARTC considers that TPIs systematic risk is strongly linked to the iron-ore mining industry rather than general rail, and the beta should reflect this. ARTC suggests that an appropriate asset beta would be in the range of 0.5-0.6, which is slightly lower than the asset beta of 0.65 applied by the ACCC for ARTC's interstate network. NWIOA endorse the approach adopted by the Authority in the 2008 Freight and Urban Railways Determination, but it is unclear precisely what this means. One interpretation is that the NWIOA endorses the Authority's original approach to estimating an asset beta, which adopted different asset betas for broad categories of traffic. This was, however, superseded by the approach in the Authority's final determination, which suggests that the NWIOA endorses the Authority's use of an equity beta of 1.00 with gearing of 35%, which implies an asset beta of approximately 0.655.[35] UMC provided no comment on systematic risk / beta.

CRA's view is that the submissions provide some support for the proposition that the appropriate beta is the beta for mining in general, and iron ore mining in particular, rather than a beta that is generally related to infrastructure or to railways.

35 The figure of 0.655 is calculated using the full version of the Monkhouse formula, using the values for the cost of debt, the corporate tax rate, and gamma applied by the Authority in the 2008 Freight and Urban Railways Final Determination

6.2.2. Formula

To calculate asset betas (de-levering) and equity betas (re-levering) we use the Monkhouse formula. The Monkhouse formula is:[36]

$$\beta e = \beta a + (\beta a - \beta d)\left[1 - \left(\frac{rd}{1+rd}\right)(1-\gamma)Te\right]\frac{D}{E}$$

where βa = the asset beta

βe = the equity beta

rd = the cost of debt

Te = the effective corporate tax rate

D = the market value of debt

E = the market value of equity

To calculate asset betas we rearrange the Monkhouse formula to give:

$$\beta a = \frac{\beta e + \beta d \cdot X}{1 + X}$$

where

$$X = \left[1 - \left(\frac{rd}{1+rd}\right)(1-\gamma)Te\right]\frac{D}{E}$$

6.2.3. Assumptions

This formulation means that it is necessary to have an estimate of gamma, the tax rate, and the cost of debt for each comparator. We note, however, that the precise value of these parameters is not critical.[37]

For the purpose of our de-levering calculations, we have assumed:

- The value of debt is equal to the difference between the reported Total Enterprise Value and the Market Capitalisation. Where the difference is negative the company has been excluded from our analysis;
- The cost of debt is equal to reported interest expense divided by the calculated value of debt;
- The value of gamma is 0.5, except for US-based firms for whom gamma is assumed to be zero (the US does not have a system of dividend imputation);

36 ACCC, *Statement of principles for the regulation of electricity transmission revenues – background paper*, 8 December 2004, p. 103.

37 See Appendix B for an analysis of the sensitivity of the Monkhouse formula to the parameter estimates.

- The tax rate is the reported effective tax rate. For those firms that do not have a reported effective tax rate we assume a tax rate of 30%. As noted above, this assumption does not result in any material error in the de-levering calculations.

6.2.4. Asset Beta Estimates for comparators

Tables 9-13 below show our estimates of the asset betas for each comparator firm and the average for each industry. Table 9 shows the asset betas for US and Canadian freight railroads, and Table 10 shows the asset betas for marine ports. In all cases the betas are calculated against the local market index.

Table 9: Asset Beta Estimates for US and Canadian Freight Railroads

Company Name	D/E	X	Be	Asset Beta, Ba	
				Bd = 0.0	Bd = 0.1
Kansas City Southern	1.02	1.00	1.50	0.75	0.80
Genesee & Wyoming Inc.	0.28	0 28	1 37	1.07	1.10
CSX Corp.	0.5	0.48	1.12	0.76	0.79
Union Pacific Corp.	0.28	0 28	0.97	0.76	0.78
Norfolk Southern Corp.	0.36	0.36	1.05	0.77	0.80
Burlington Northern Santa Fe Corp.	0.31	0.30	0.88	0.68	0.70
Canadian Pacific Railway Limited	0 73	0 73	0.91	0.53	0.57
Canadian National Railway Company	0.30	0.30	0.68	0.52	0.54
Total	0.37			0.69	0.72

Source: Calculated from data downloaded from CapitalIQ and Datastream, 20 November 2008.

These equity betas were calculated based on weekly data available for these firms on Datastream and measured against the appropriate US and Canadian market indices.

Table 10: Asset Beta Estimates for Marine Ports

Company Name	D/E	X	Be	Asset Beta, Ba	
				Bd = 0.0	Bd = 0.1
Eurokai KGaA	0.65	0.64	1.93	1.18	1.22
Forth Ports plc	0.54	0.53	1.15	0.75	0.79
Royal Vopak NV	0.52	0.52	1.15	0.76	0.79
Port of Tauranga Ltd.	0.23	0.22	0.50	0.41	0.43
Lyttelton Port Co. Ltd.	0.25	0.25	0.24	0.19	0.21
Total	0.49			0.76	0.79

Source: Calculated from data downloaded from CapitalIQ, 20 November 2008.

The estimation of betas for firms in the "Iron Ores" and "Diversified Minerals" industries presents additional challenges because of the large contribution that firms in these industries make to the Australian market. If a firm or industry comprises a relatively large proportion of the market index then the equity betas for that firm or industry will be biased upwards (in other words, their equity betas no longer contain just the systematic risk component). To correct for the bias that exists from measuring such betas against the Australian all ordinary shares index, we estimate betas for firms such as BHP Billiton and Rio Tinto against the world market (see Appendix C).

Since mining firms in Australia represent a high proportion of the overall market, equity betas for these firms were calculated against the world market index rather than the Australian all ordinary shares index.

Table 11: Asset Beta Estimates for 'Iron Ores'

Company Name	D/E	X	Be	Asset Beta, Ba	
				Bd = 0.0	Bd = 0.1
United States Steel Corp.	0.76	0.75	3.07	1.75	1.79
Cliffs Natural Resources Inc.	0.13	0.13	2.07	1.83	1.85
Fortescue Metals Group Ltd.	1 61	1.56	2.18	0.85	0.91
Mount Gibson Iron Ltd.	0.51	0.49	1.86	1.25	1.28
Territory Resources Limited	0.98	0.97	1.54	0.78	0.83
Total	0.85			1.37	1.41

Source. Calculated from data downloaded from CapitalIQ, 20 November 2008.

Table 12: Asset Beta Estimates for 'Diversified Minerals'

Company Name	D/E	X	Be	Asset Beta, Ba	
				Bd = 0.0	Bd = 0.1
BHP Billiton Ltd.	0.09	0.09	1.07	0.98	0.99
Rio Tinto Ltd.	1.24	1.21	1.08	0.49	0.54
Total	0.39			0.77	0.80

Source: Calculated from data downloaded from CapitalIQ, 20 November 2008 and Datastream.

Table 13: Asset Beta Estimates for 'Mining Services'

Company Name	D/E	X	Be	Asset Beta, Ba	
				Bd = 0.0	Bd = 0.1
Orica	0.21	0.21	0.87	0.72	0.74

Source: Calculated from data downloaded from CapitalIQ, 20 November 2008 and Datastream.

6.2.5. Conclusions on asset beta

Table 14 summarises the asset beta estimates for the comparator industries.

In our view the beta for a general infrastructure business related to the movement of freight should be based on the estimates for the diversified Canadian and US freight railroads and marine ports, although the diversified nature of those railways and ports mean that they are not particularly good comparators to TPI. Weighting the asset betas by total enterprise value, this suggests an asset beta of 0.67 if the debt beta is zero, and an asset beta of 0.69 if the debt beta is 0.1. Due to the much larger value of the Canadian and US freight railroads, these asset beta estimates are essentially identical to the betas of the freight railroads alone.

Within the set of Canadian and US railroads, Genesee & Wyoming provides the only example of regional short line railroads. The number of such railroads owned means that Genesee & Wyoming will have considerable diversity across the various lines, so could in some ways be considered to be a proxy for the "short line railroad" industry. Short line railroads would be a better approximation to TPI than the large trans-national railroads, providing an asset beta of 1.07 if the debt beta is zero and an asset beta of 1.10 if the debt beta is 0.1. However, the large statistical errors inherent in beta estimation mean that reliance on a single comparator is always subject to considerable error. For this reason we do not recommend the use of Genesee & Wyoming as a single comparator.

Finally, as we have previously discussed, we expect that there would be some sharing of risk between mines and an independent ore-carrying railway. As a result we would expect that the asset beta for such a railroad would like somewhere between the beta for a diversified freight railway and the beta for mining. The average asset beta, weighted by enterprise value, across both infrastructure and mining-related industries is 0.77 if the debt beta is zero, and 0.79 if the debt beta is 0.1.

Table 14: Summary of Asset Beta Estimates Derived from Capital Market Data

Industry	Total Enterprise Value ($M)	Number of Firms	Asset Beta, Ba	
			Bd = 0.0	Bd = 0.1
Canadian and US Freight Railroads	154,375.4	8	0.69	0.72
Marine Ports	5,478 7	5	0.76	0.79
Iron Ores	15,070.4	5	1.37	1.41
Diversified Minerals	281,658.4	2	0.77	0.80
Mining Services	10,420.9	1	0.72	0.74
Weighted Average of Freight Railroads and Marine Ports			0.69	0.72
Weighted Average of Iron Ores, Diversified Minerals, and Mining Services			0.80	0.83
Weighted Average of All Comparators			0.77	0.79

Source: Calculated from data downloaded from CapitalIQ, 20 November 2008.

7. THE MARKET RISK PREMIUM

The appropriate value for the Market Risk Premium lies outside the scope of this project. However, we do have some comments on the issues raised in submissions.

Some submitters argue for a different Market Risk Premium (MRP) than the MRP used by the Authority in its various WACC determinations. Some argue for a higher MRP based on recent studies, while others argue for a lower MRP either to reflect the MRP used in a foreign market or for other project-specific factors (e.g. NWIOA). The appropriate MRP is the MRP for the Australian market as a whole, and estimates for foreign markets are therefore not particularly relevant, and there is no case for altering the MRP on a project-specific basis. There is, however, a case that recent studies should be considered by the Authority, but we recommend that this occurs as a separate consultative exercise involving all the industries regulated by the Authority, as the same value should be applied across all industries.

Consistent with other WACC determinations by the Authority, we have applied a Market Risk Premium of 6%.

8. THE WEIGHTED AVERAGE COST OF CAPITAL

8.1. PRE-TAX NOMINAL WACC

The pre-tax nominal WACC is calculated using the Officer formula:

$$WACC = re\frac{1}{1-T(1-\gamma)}\cdot\frac{E}{V}+rd\cdot\frac{D}{V}$$

where re = the cost of equity $= rf + \beta e \cdot MRP$

rd = the (pre - tax) cost of debt

T = the statutory corporate tax rate

$V = \mathrm{D} + \mathrm{E}$

We calculate a post-tax nominal WACC using the formula:

$$WACC = re\cdot\frac{E}{V}+rd(1-T)\cdot\frac{D}{V}$$

Given the parameter values above, we calculate that the post-tax nominal WACC and pre-tax real WACC for TPI as shown in Table 15. Rather than using the point estimate of 0.04 for the asset beta, we use lower- and upper-bounds of 0 and 0.1 respectively.

Based on our recommended approach and parameter values, the post-tax nominal WACC for TPI would be 9.19% (debt beta of 0.1) and 9.21% (debt beta of 0).

For an infrastructure-only WACC with recommended parameter values, the post-tax nominal WACC would be 8.74% (debt beta 0.1) and 8.75% (debt beta 0). If gamma is increased to 0.5, which we do not recommend, then the post-tax nominal WACC is 8.75% (debt beta of 0.1) and 8.76% (debt beta of 0). The choice of gamma does not materially alter the post-tax nominal WACC because its only influence is via the calculation of the equity beta, and its effect on the equity beta is small.

In all cases the debt beta makes no material difference to the WACC. Any variations introduced because of the debt beta are minimal compared to the degree of uncertainty in the various parameters.

Table 15: Calculation of Post-Tax Nominal WACC

		Infrastructure and Mining		Infrastructure			
				Gamma = 0.23		Gamma = 0.5	
Risk free RoR	rf	4.369%	4.369%	4.369%	4.369%	4.369%	4.369%
Gearing	D	32%	32%	28%	28%	28%	28%
Debt Premium (bps)	p	295.4	295.4	295 4	295.4	295 4	295.4
Debt Issuance Costs (bps)	dic	12.5	12 5	12.5	12 5	12.5	12 5
Cost of debt	rd	7 45%	7.45%	7 45%	7 45%	7.45%	7.45%
Market risk premium	MRP	6 00%	6.00%	6 00%	6 00%	6.00%	6.00%
Corporate tax rate	T	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

Gamma	γ	0.23	0.23	0.23	0.23	0.5	0.5
Asset Beta	*Ba*	0.77	0.79	0.69	0.72	0.69	0.72
Debt Beta	*Bd*	0	0.1	0	0.1	0	0.1
	D/E	0.471	0.471	0.389	0.389	0.389	0.389
	X	0.463	0.463	0.382	0.382	0.385	0.385
Equity Beta	*Be*	1.12	1.12	0.96	0.96	0.96	0.96
Required Return on Equity	*re*	11.09%	11.06%	10.12%	10.12%	10.13%	10.12%
Post tax nominal WACC	w_N	9.21%	9.19%	8.75%	8.74%	8.76%	8.75%

8.2. Pre-Tax Real WACC

We would generally recommend the use of a post-tax nominal WACC applied within a model that explicitly calculates benchmark tax payments by the regulated firm. Our preference for this approach is because in theory it more accurately models the cash flows faced by investors in the benchmark firm, and the post-tax WACC is consistent with the post-tax returns required by providers of capital.

We note, however, that the Authority's practice is to apply a real pre-tax WACC without modelling tax payments. Consistency with the 2008 Freight and Urban Railways Determination is one reason to adopt a pre-tax real WACC in the present determination, but consistency with previous decisions should not be treated as an over-riding consideration (i.e. the Authority should be open to changing the method in future if there was sufficient reason to do so).

We also note that the pre-tax real approach appears to be accepted by submitters. The pre-tax method loses some accuracy, but if it is accepted by stakeholders it avoids contentious arguments over how to calculate the benchmark tax allowance and the items that should be included in, or excluded from, that allowance. In New Zealand, for example, an inconsistency between the treatment of taxation and the valuation of the regulatory asset base means that allowed revenues decrease if a firm pays above the regulatory value for assets.[38]

8.2.1. Inflation Estimate

It has recently been recognised by regulators that estimates of future inflation derived using inflation-indexed bonds are biased upwards. This is because there is a limited supply of inflation-indexed bonds, which tends to result in prices being "too high" and hence returns on inflation-indexed bonds being too low. When compared with nominal bonds the effect is to overstate future inflation.

One approach is to adopt the mid-point of the Reserve Bank of Australia's inflation target band, i.e. 2.5%. We consider that this is likely to provide reasonable outcomes.

38 See, for example, the discussion in CRA (2005) *Review of the Commerce Commission's Intention to Declare Control of Unison*, Final Report, 28 October, pp. 32–42.

Another approach is to derive an estimate of inflation based on inflation forecasts. This is essentially the approach adopted by the Authority in the 2008 Freight and Urban Railways Determination. To the extent that the forecasts represent the market's best estimate of future inflation this method is likely to provide the most appropriate outcomes.

8.2.2. Estimate of the Pre-Tax Real WACC

The approach adopted by the Authority is to:

- First convert the post-tax nominal WACC to a pre-tax nominal WACC by dividing through by (1 – T); and
- The pre-tax nominal WACC is then adjusted for inflation to obtain a pre-tax real WACC.

Table 16 shows our calculation of the pre-tax real WACC values corresponding to the post-tax nominal WACC values on Table 15. We use an indicative inflation estimate of 2.5% for these calculations, noting that inflation expectations could change significantly between now and the draft and final determinations.

Based on our recommended approach and parameter values, the pre-tax real WACC for TPI would be between 9.43% (debt beta of 0.1) and 9.46% (debt beta of 0) respectively.

For an infrastructure-only WACC with recommended parameter values, the pre-tax real WACC would be 8.84% with a debt beta of either 0 or 0.1. If gamma is increased to 0.5, which we do not recommend, then the pre-tax real WACC decreases to 7.96% (debt beta of 0.1) and 7.97% (debt beta of 0) respectively.

Again in all cases the debt beta makes no material difference to the WACC and any variations introduced because of the debt beta are completely swamped by the degree of uncertainty in the various parameters. We recommend that the Authority applies a debt beta of zero.

Table 16: Calculation of Pre-Tax Real WACC

		Infrastructure and Mining		Infrastructure			
				Gamma = 0.23		Gamma = 0.5	
Debt Beta	Bd	0	0.1	0	0.1	0	0.1
Post tax nominal WACC	w_N	9.21%	9.19%	8.75%	8.74%	8.76%	8.75%
Pre-tax nominal WACC		12.19%	12.16%	11.56%	11.56%	10.67%	10.66%
Inflation		2 50%	2 50%	2 50%	2 50%	2.50%	2.50%
Pre-tax real WACC	w_R	9.46%	9.43%	8.84%	8.84%	7.97%	7.96%

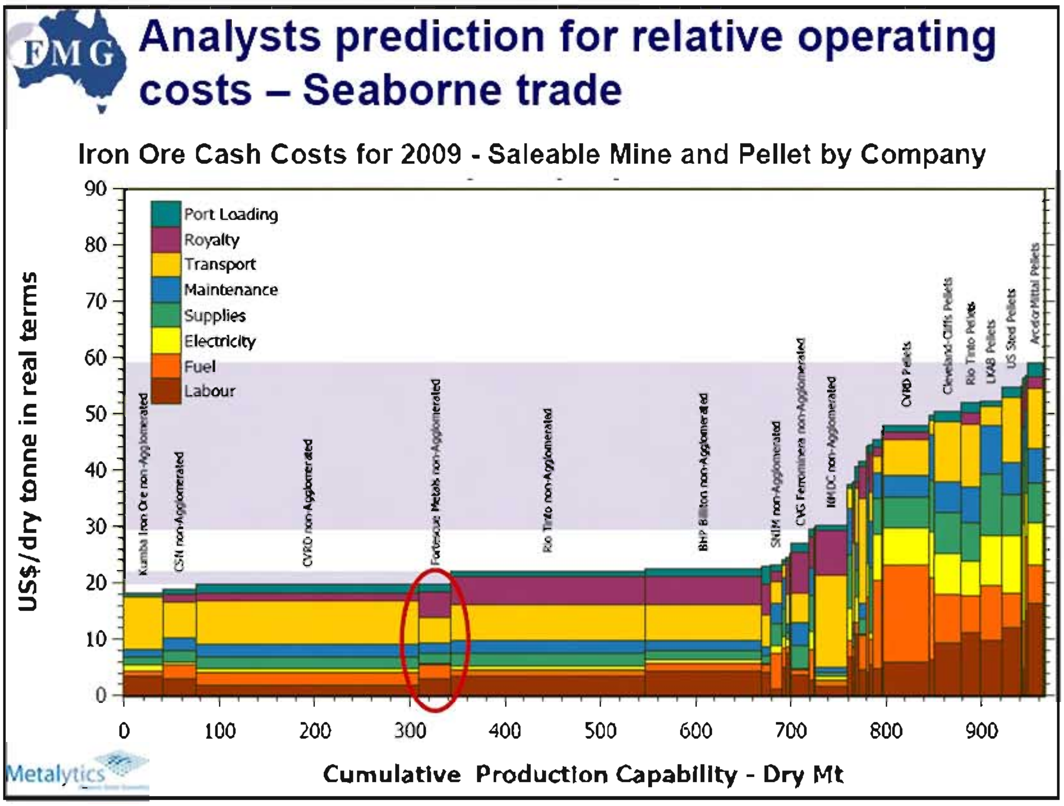
9. ASYMMETRIC RISK

TPI's original application to the ERA argued strongly for compensation for asymmetric risk. All parties other than TPI commented on the treatment of asymmetric risk in their submissions in response to the Issues Paper.

NWIOA, and UMC presented material arguing that there is considerable demand for iron ore, particularly from the growing economies of India and China. The suggestion is made that this growth would continue for the foreseeable future, thus making it unlikely that there was any material stranding risk. We are less convinced about the potential for such trends to continue unabated, with the prospect of sustained global recession being a genuine concern at the moment. Such a recession could cut exports from China and India, ultimately dampening the growth in those economies, and better enabling them to rely on domestic iron ore and steel production. It is therefore appropriate to consider the risk of FMG needing to cut production if there was a sustained global recession.

One of the more powerful arguments against stranding risk was provided in a chart that NWIOA and UMC reproduce from one of FMG's own presentations (see Figure 5 below). This chart provides FMG's estimate of a supply curve for iron ore, and indicates that FMG's operations in the Pilbara will be relatively low cost.

Figure 5: FMG's Estimate of the Supply Curve for Iron Ore



Source: Fortescue Metals Group, *The New Force in Iron Ore*, JP Morgan Asia Pacific & Emerging Markets Equity Conference, September 3-5, 2008. A similar chart was released as part of the slides for FMG's Annual General Meeting 2008.

One implication from this chart is that if world iron ore demand does contract, there are other high cost producers who would be forced to shut down well before FMG's Pilbara operations (i.e. those at the right hand side of the chart).

We also note from the chart that FMG's Pilbara operations produce a relatively small quantity of iron ore relative to CVRD, Rio Tinto, and BHP Billiton. The significance of this from an economic perspective is that FMG's production volumes are unlikely to influence market price, but production volumes from the three large producers could have an influence on price. If demand for iron ore falls and market prices also drop, then the three large producers may have an incentive to reduce production volumes in order to support market prices. While the likelihood of this depends on the price elasticity of demand in the international market for iron ore, it further indicates that other mining operations are likely to reduce production before FMG.

Consistent with this assessment, FMG recently had a temporary shutdown of the port in order to *expand* loading capacity, allowing it to achieve its target of 55 million tonnes per annum.[39]

We agree, therefore, that on the balance of available evidence the stranding risk for the overall TPI railway does not appear to be large.

Although stranding risk in total does not appear to be large, it is still possible that stranding risk could be material for particular parts of the TPI system, particularly in relation to parts of the network that have been constructed specifically at the request of third parties. It is reasonable, therefore, to have some means of providing compensation for, or protection against, asymmetric risk.

Suggestions were made by various parties on alternative means for compensating for asymmetric risk, with Hancock and the NWIOA noting that asymmetric risk should not be compensated in the WACC if it is already allowed for elsewhere. TPI's own proposals to utilise accelerated depreciation were noted by NWIOA and UMC, as was the ability for TPI to require up-front capital contributions to help meet the cost of capacity expansions. ARTC suggests the adoption of a "loss capitalisation" approach – whereby losses over the early period of the project are capitalised – in preference to accelerated depreciation. ARTC also suggests that an increment on the WACC or selecting a value from the upper end of a range of values could understate the risks to TPI. The NWIOA noted that the railway should not be treated as a whole when assessing stranding risk – we agree with this and note that individual branch connections and capacity upgrades for a specific user are far more likely to be stranded than the mainline. The NWIOA and UMC propose an approved programme of Major Periodic Maintenance as an alternative to depreciation.

39 See FMG press release "Loading Recommences after Expansion Shut Down, Mining to finish Calendar Year Strongly, Shipping to put in a Solid Performance Despite the Shut", 26 November 2008

We consider the vast majority of all of these points are very valid, but it is unclear whether NWIOA's suggested treatment of Major Periodic Maintenance would provide full compensation to TPI. TPI's original submission suggested ways to increase the WACC to compensate for asymmetric risk. As we noted in the Issues Paper, a number of the options reviewed by TPI are extremely complex to implement and there is a lack of good data for developing a robust estimate. Our view is that the various measures suggested above provide a more robust means of dealing with asymmetric risk, and benefit from not relying on contentious estimates of what an appropriate risk premium might be. Up-front capital contributions will eliminate stranding risk for the portion of any capacity expansion that is covered by the contribution, and accelerated depreciation would significantly reduce stranding risk for the residual.

In summary, NWIOA and UMC argued strongly that there is little risk of a large scale reduction in demand (and hence stranding), while ARTC noted that there has been a drop-off in orders from some suppliers. We are somewhat less optimistic about the future than the NWIOA or UMC, but we also note that a supply curve produced by FMG suggests that FMG's Pilbara operations could be largely insulated in the event of a decline in demand. Nevertheless, it is reasonable for TPI to require some protection against asymmetric risk. There are a range of mechanisms available for this that do not rely on contentious estimates of an additional premium, including accelerated depreciation, up-front capital contributions, alternative treatment of major periodic maintenance, etc. We recommend that the Authority uses those mechanisms to minimise asymmetric risk rather than increasing the WACC.

APPENDIX A: COMPARATOR COMPANIES

Business descriptions provided by CapitalIQ.

Company Name	Business Description
US and Canadian Freight Railroads	
Kansas City Southern (NYSE:KSU)	Kansas City Southern, through its subsidiaries, provides domestic and international rail transportation services in the United States and Mexico. It operates north/south rail between Kansas City, Missouri, and various ports along the Gulf of Mexico in Alabama, Louisiana, Mississippi, and Texas in the midwest and southeast regions of the United States. The company also operates direct rail passageway between Mexico City and Laredo in Texas, serving various Mexico's industrial cities and 3 of its shipping ports; operates a 157-mile rail line extending from Laredo to the port city of Corpus Christi, Texas; and owns the northern half of the rail bridge at Laredo, Texas. In addition, it holds a concession to operate a 47-mile railroad located adjacent to the Panama Canal, as well as operates and promotes commuter and tourist passenger services. Further, the company operates a bulk materials handling facility with deep-water access to the Gulf of Mexico at Port Arthur, Texas that stores and transfers petroleum coke from rail cars to ships primarily for export; and a railroad wood tie treatment facility. Kansas City Southern serves customers conducting business in various industries, including electric-generating utilities, chemical and petroleum products, forest products and metals, agriculture and mineral products, automotive products, and intermodal transportation. The company was founded in 1962 as Kansas City Southern Industries, Inc. and changed its name to Kansas City Southern in 2002. Kansas City Southern is based in Kansas City, Missouri.
Genesee & Wyoming Inc. (NYSE:GWR)	Genesee & Wyoming, Inc., through its subsidiaries, owns and operates short line and regional freight railroads in the United States, Australia, and Canada. The company's railroads transport various commodities, such as pulp and paper; coal, coke, and ores; metals; minerals and stone; lumber and forest products; farm and food products; chemicals and plastics; petroleum products; and autos and auto parts. As of December 31, 2007, Genesee & Wyoming, Inc. owned, leased, or operated 48 short line and regional freight railroads with approximately 5,800 miles of owned and leased track; and approximately 3,000 additional miles under track access arrangements. It served 12 United States ports and 5 Australian ports. The company also provides rail freight transport and ancillary logistics services to the mining and agricultural industries, as well as to the general freight market within Western Australia and South Australia In addition, it owns a minority interest in railroad in Bolivia. Genesee & Wyoming, Inc. was founded in 1899 and is headquartered in Greenwich, Connecticut.
CSX Corp. (NYSE:CSX)	CSX Corporation provides rail-based transportation services in North America. The company offers traditional rail service and the transport of intermodal containers and trailers. It also provides coast-to-coast intermodal transportation services linking customers to railroads, through trucks and terminals. CSX Corporation transports crushed stone, sand and gravel, metal, phosphate, fertilizer, food, consumer, agricultural, paper, and chemical products. In addition, it delivers coal, coke, and iron ore to electricity generating power plants, as well as finished vehicles and auto parts. The company also engages in the real estate sale, leasing, acquisition, and management and development activities; the operation of a resort, and leasing equipment and vessels. As of December 28, 2007, it operated approximately 21,000 route mile rail network, 4,000 locomotives, and 222,000 freight car fleet, serving various

Company Name	Business Description
	population centers in 23 states east of the Mississippi River, the District of Columbia, and the Canadian provinces of Ontario and Quebec. CSX Corporation was founded in 1827 and is based in Jacksonville, Florida.
Union Pacific Corp. (NYSE.UNP)	Union Pacific Corporation, through its subsidiary, Union Pacific Railroad Company, provides rail transportation services in North America. It has approximately 32,205 route miles linking Pacific Coast and Gulf Coast ports with the Midwest and eastern United States gateways, and provides various corridors to Mexican gateways. The company offers transportation services for agricultural products, automotive, energy, lumber, steel, paper, food, chemicals, coal, and industrial products, as well as for finished vehicles and intermodal containers. Union Pacific Corporation was founded in 1862 and is based in Omaha, Nebraska.
Norfolk Southern Corp. (NYSE:NSC)	Norfolk Southern Corporation, through its subsidiaries, engages in the rail transportation of raw materials, intermediate products, and finished goods primarily in the United States. Its operations consist of transportation of coal, coke, and iron ore products; general merchandise traffic, which consists of automotive products, chemicals, metals and construction products, agriculture and consumer products, and paper, clay, and forest products, and intermodal traffic. Automotive products include finished vehicles and auto parts Metals and construction products comprise steel, aluminum products, machinery, scrap metals, cement, aggregates, bricks, and minerals. Agriculture and consumer products include soybeans, wheat, corn, fertilizer, animal and poultry feed, food oils, flour, beverages, canned goods, sweeteners, consumer products, and ethanol. Paper, clay, and forest products comprise lumber and wood products, pulp board and paper products, wood fibers, wood pulp, scrap paper, and clay. Intermodal traffic includes shipments moving in trailers, domestic and international containers, and roadrailer equipment. It handles these shipments on behalf of intermodal marketing companies, international steamship lines, truckers, and other shippers. The company also transports overseas freight through various Atlantic and Gulf Coast ports, as well as provides a range of logistics services. It also operates and leases regularly scheduled passenger trains and commuter trains; acquires, leases, and manages coal, oil, gas, and minerals; develops commercial real estate; telecommunications; and leases or sells rail property and equipment. As of December 31, 2007, the company operated approximately 21,000 route miles in 22 states in the United States and the District of Columbia. Norfolk Southern Corporation was founded in 1830 and is based in Norfolk, Virginia.
Burlington Northern Santa Fe Corp. (NYSE:BNI)	Burlington Northern Santa Fe Corporation, through its subsidiaries, engages primarily in the freight rail transportation business. It transports various products and commodities, including consumer, industrial, coal, and agricultural products. The shipments of consumer products include automotive, such as motor vehicles and vehicle parts. The company also offers transportation services for industrial products, including construction products, such as clays, sands, cements, aggregates, sodium compounds, and other industrial minerals; building products comprising lumber, plywood, oriented strand board, particleboard, paper products, pulpmill feedstocks, wood pulp, and sawlogs; petroleum products, such as liquefied petroleum gas, diesel fuels, asphalt, alcohol, solvents, petroleum coke, lubes, oils, waxes, and carbon black; chemicals and plastic products, including caustic soda, chlorine, industrial gases, acids, polyethylene, polypropylene, and polyvinyl chloride; and food and beverages, such as canned goods and perishable food items, as well as cotton, salt, rubber and tires, and miscellaneous boxcar shipments. In addition, it transports coal products; and agricultural products, such as wheat, corn, bulk foods, soybeans, oil seeds and meals, feeds, barley, oats and rye, flour and mill products, milo, oils, specialty grains, malt, ethanol, and fertilizers. As of December 31, 2007, Burlington Northern Santa Fe operated a railroad system consisting of approximately 32,000 route miles in 28 states and 2 Canadian provinces. The company was founded in 1994 and is based in Fort Worth, Texas

Company Name	Business Description
Canadian Pacific Railway Limited (TSX:CP)	Canadian Pacific Railway Limited, through its subsidiaries, operates a transcontinental railway in Canada and the United States. The company provides logistics and supply chain expertise. It offers rail and intermodal freight transportation services over approximately 13,200-mile railway network. The company transports bulk commodities, including, grain, coal, sulphur, and fertilizers; merchandise freight that consist of finished vehicles and automotive parts; and intermodal traffic, which includes time-sensitive retail goods, as well as forest, industrial, and consumer products. Canadian Pacific Railway Limited was founded in 1881 and is based in Calgary, Canada. Canadian Pacific Railway Limited (TSX.CP) operates independently of Canadian Pacific Limited as of October 01, 2001.
Canadian National Railway Company (TSX:CNR)	Canadian National Railway Company, together with its subsidiaries, engages in the rail and related transportation business in North America. It provides transportation for various goods, including petroleum and chemicals, metals and minerals, forest products, coal, grain and fertilizers, and automotive products, as well as intermodal transportation of consumer products and manufactured goods. As of December 31, 2007, the company operated a network of approximately 20,400 route miles of track spans Canada and mid-America, connecting three coasts: the Atlantic, the Pacific, and the Gulf of Mexico. It serves ports of Vancouver; Prince Rupert; B.C.; Montreal; Halifax, and New Orleans and Mobile, Alabama, as well as the cities of Toronto, Buffalo, Chicago, Detroit, Duluth, Minnesota/Superior, Wisconsin, Green Bay, Wisconsin, Minneapolis/St. Paul, Memphis, St. Louis, and Jackson, Mississippi, with connections to various points in North America. The company was founded in 1922 and is headquartered in Montreal, Canada
Marine Ports	
Eurokai KGaA (XTRA:EUK3)	Eurokai KGaA operates as a financial holding company. The company, through its subsidiaries, engages in container handling operations in Europe. It operates container terminals in La Spezia, Gioia Tauro, Livorno, Cagliari, Ravenna, and Salerno, Italy; Bremerhaven and Hamburg, Germany; and Lisbon, Portugal, as well as involves in terminal projects in Wilhelmshaven, Germany; Tangier, Morocco; and Ust-Luga, Russia. The company also provides cargo-modal services, such as goods distribution and storage; intermodal services, such as carriage of sea containers to and from terminals; repair, storage, and sale of containers; technical services; and IT services. The company was founded in 1961 and is headquartered in Hamburg, Germany.
Forth Ports plc (LSE:FPT)	Forth Ports PLC, along with its subsidiaries, provides port, cargo handling, towage, and related services and facilities in the United Kingdom. The company owns the ports of Grangemouth, Leith, Rosyth, Burntisland, and Methil within the Firth of Forth, Port of Dundee on the Firth of Tay; Port of Tilbury on the River Thames; and Chatham in Kent and Tilbury. It provides other marine services, including towage and conservancies. The company also involves in property letting and development activities. In addition, Forth Ports engages in paper handling, waste management, and waste sourcing and distribution activities. It manages and operates an area of 280 square miles of navigable waters, including 2 specialized marine terminals for oil and gas export within and around the Firths of Forth and Tay. Forth Ports PLC has a strategic venture agreement with Scottish & Southern Energy plc to develop renewable energy projects in Scotland and England. The company is headquartered in Edinburgh, the United Kingdom.

Company Name	Business Description
Royal Vopak NV (ENXTAM:VPK)	Royal Vopak N.V., an independent tank terminal operator, engages in the storage and transfer of liquid oil products, chemicals, vegetable oils, and liquefied gases. It operates a network of tank terminals, including import, export, or distribution terminals, hub terminals; and industrial terminals for governments, and producers of and traders in oil products and chemicals. As of April 29, 2008, the company operated a network of 76 terminals with a global storage capacity of 26 million cubic meters in Europe, the Middle East, Africa, Asia, North America, and Latin America. It also offers barging, port and hub agency, tanker shipping, land transport, sea transport, airfreight, forwarding, customs formalities, and agencies. The company is headquartered in Rotterdam, the Netherlands.
Port of Tauranga Ltd. (NZSE:POT)	Port of Tauranga Limited operates the Port of Tauranga in New Zealand. Its activities include provision of wharf facilities; land for storage and transit of import and export cargoes; berthage, cranes, tug, and pilotage services; leasing of land and buildings; container terminal ownership; and provision of rail link to Auckland (Metroport). The company also engages in the storage, cleaning, washing, and inspection of shipping containers at the Southdown rail terminal at Auckland; ownership and operation of deepwater commercial port at Marsden Point; and ownership of tugs, and operation of towage in the Whangarei Harbour. In addition, it involves in the provision of log scaling, stevedoring, inventory management, receival and delivery, warehousing, on-wharf marshalling, devanning and consolidating containers/bases, road transport, materials handling, and vessel agency services. As of June 30, 2008, the company operated 13 ports and 3 log yards in New Zealand. It serves various industries and businesses in New Zealand, which trade with international markets in Australia, Asia, the Middle Eastern Gulf, the Pacific Islands, South America, the United States, and Europe. The company was founded in 1873 and is based in Tauranga, New Zealand. Port of Tauranga Limited is a subsidiary of Quayside Securities Limited.
Lyttelton Port Co. Ltd. (NZSE:LPC)	Lyttelton Port Company Limited provides and manages port facilities, marine services, and cargo handling operations at Lyttelton and Woolston, Christchurch, New Zealand. Its ports offer wharves, secure storage sheds, bulk discharge, and other facilities for a range of conventionally stevedored cargoes The company's facilities provide unloading of bulk products, including petroleum, fertilizer, gypsum, conventional break-bulk, imported vehicles, farm machinery, fishing, and various other cargoes Its marine services include the provision of tugs, pilots to escort ships into and out of the port, staff to assist with ships' lines when ships are berthing, and security. Lyttelton Port Company's container terminal provides specialized cargo handling and stevedoring services for containers and plant hire. The company is based in Christchurch, New Zealand. Lyttelton Port Company Limited is a subsidiary of Christchurch City Holdings Limited.
Mining Services	
Orica Ltd.	Orica Limited engages in the manufacture and distribution of mining products and services, consumer products, chemical products, and chemical services. The company's Mining Services segment manufactures and supplies explosives and mining services, initiating systems, and blasting technology to the mining, quarrying, construction, and exploration industries. Its Minova segment provides specialist chemical products for underground mining and civil engineering activities. These products include resin capsules, powders, and injection chemicals for use in strata support, ground consolidation, and ventilation systems The company's Consumer Products segment manufactures and supplies paints and other surface coatings to the decorative and technical markets; and a range of home handyman, car care, and garden care products. Its Chemnet segment engages in the

Company Name	Business Description
	distribution and trading of a range of industrial and specialty chemicals, raw materials, and ingredients, as well as provides associated services to various manufacturers The company's Chemical Services segment manufactures and supplies a range of industrial and specialty chemicals, including chlorine, MIEX DOC resin, sodium hypochlorite, caustic soda, and related chemicals for water care, food, timber, and general industrial purposes, as well as sodium cyanide to the gold mining industry. It operates primarily in Australia, New Zealand, the Americas, Europe, and Asia. The company was incorporated in 1928 as Imperial Chemical Industries of Australia and New Zealand and changed its name to ICI Australia Limited in 1971. Further, it changed its name to Orica Limited in 1998. The company is headquartered in Melbourne, Australia
Diversified Minerals	
BHP Billington Ltd.	BHP Billiton Limited, together with its subsidiaries, operates as a diversified natural resources company. The company engages in producing alumina and aluminum, copper, coal, iron ore, nickel, manganese, metallurgical coal, oil and gas, and uranium, as well as gold, zinc, lead, silver, and diamonds. BHP Billiton was founded in 1885 and is headquartered in Melbourne, Australia.
Rio Tinto Ltd.	Rio Tinto Limited engages in exploring, mining, and processing a range of metals and minerals The company's products include alumina, aluminum, and bauxite; borates; coal; copper; diamonds; gold and silver; gypsum; iron ore; molybdenum; salt; sulphuric acid; talc; titanium dioxide; ilmenite, rutile, and zircon; uranium; and nickel, potash, lead, and zinc. It primarily operates in Australia and New Zealand, North America, South America, Asia, Europe, and Africa. The company was founded in 1873 and is headquartered in Melbourne, Australia.
Oxiana Ltd.	OZ Minerals Limited operates as a diversified mining company. It primarily produces zinc, copper, lead, gold, and silver. The company has five mining operations located in Australia and Asia, three new mining projects in development and a portfolio of exploration projects throughout Australia, Asia, and North America. OZ Minerals Limited is based in Melbourne, Australia
Iron Ores	
United States Steel Corp. (NYSE:X)	United States Steel Corporation produces steel products. It operates through three segments: Flat-rolled Products, U. S. Steel Europe, and Tubular Products. The Flat-rolled Products segment produces slabs, sheets, tin mill products, strip mill plates, rounds, and coke. It serves customers in the service center, conversion, transportation, construction, container, and appliance and electrical markets in North America. The U.S. Steel Europe segment manufactures and sells sheet, strip mill plate, tin mill, and tubular products, as well as heating radiators and refractories. It serves customers in the central, western, and southern European construction, service center, conversion, container, transportation, and appliance and electrical, as well as oil, gas, and petrochemical markets. The Tubular products segment produces and sells seamless and welded tubular products for the oil, gas, and petrochemical markets. United States Steel Corporation also involves in the production and sale of iron ore pellets, as well as the provision of transportation services. In addition, it owns, develops, and manages various real estate assets, which include approximately 200,000 acres of surface rights primarily in Alabama, Maryland, Michigan, Minnesota, and Pennsylvania; participates in joint ventures that develop real estate projects in Alabama, Illinois, and Maryland; and owns approximately 4,000

Company Name	Business Description
	acres of land in Ontario, Canada. Further, the company provides engineering and consulting services, which include the preparation of studies, mine and process audits, basic and detailed engineering, project and construction management, procurement, start-up and commissioning, and training and operations assistance to the mining and mineral processing sectors. United States Steel Corporation was founded in 1901 and is headquartered in Pittsburgh, Pennsylvania.
Cliffs Natural Resources Inc. (NYSE:CLF)	Cliffs Natural Resources, Inc. produces iron ore pellets and supplies metallurgical coal to the steelmaking industry primarily in North America. It operates six iron ore mines in Michigan, Minnesota, and Eastern Canada; and three coking coal mines in West Virginia and Alabama. The company also owns Portman Limited, an iron ore mining company in Australia. In addition, it has a 30% interest in the Amapa Project, a Brazilian iron ore project; and a 45% economic interest in the Sonoma Project, an Australian coking and thermal coal project. The company was formerly known as Cleveland-Cliffs, Inc. and changed its name in October, 2008. Cliffs Natural Resources, Inc. was founded in 1847 and is headquartered in Cleveland, Ohio.
Fortescue Metals Group Ltd. (ASX:FMG)	Fortescue Metals Group Limited engages in the development of Pilbara iron ore and infrastructure project. It involves in the acquisition, exploration, and production of iron ores in Australia. The company also designs, finances, and constructs rail and port facilities. Fortescue Metals Group is based in East Perth, Australia.
Mount Gibson Iron Ltd. (ASX:MGX)	Mount Gibson Iron Limited, together with its subsidiaries, engages in mining, exploring, and developing iron ore deposits in Australia. The company was founded in 1996 and is based in West Perth, Australia.
Ferrowest Limited (ASX:FWL)	Ferrowest Limited engages in mineral exploration in Australia. It holds a 100% interest in Yalgoo iron project that produces merchant pig iron from iron resources in the Yogi deposit in Yalgoo, Western Australia. The company was founded in 2005 and is based in Belmont, Australia.
Territory Resources Limited (ASX:TTY)	Territory Resources Limited, together with its subsidiaries, engages in the production, exploration, and development of iron ore properties in Australia. It owns interests in the Frances Creek project comprising 13 deposits located north of the regional town of Pine Creek, and the Mt Bundey project, which consists of 2 exploration licenses and 1 exploration license application totaling of 241 square kilometers situated in the east southeast of Darwin. The company also holds interests in the Yarram project that comprise 4 tenements on the Yarram and Batchelor prospect areas located 100 kilometers south of Darwin; and the Warrego Tailings project located 945 kilometers south of Darwin. Territory Resources is based in West Perth, Australia
OneSteel Ltd (ASX:OST)	OneSteel Limited engages in the mining, and manufacture and distribution of steel long products in Australia and internationally. The company's products include structural, rail, rod, merchant bar, cold finished bar, chrome plated bar, reinforcing, wire, tube, pipes, fittings, valves and actuation, rail wheels and axles, lite steel beam, grinding media, and recycled metals. It also offers aluminum, bar sections, building products, pilings, tubes, plate, railway track products, and sheet and coil products. The company's products are primarily used in the construction, manufacturing, housing, mining, agricultural, fishing and forestry, and transport and storage sectors. OneSteel Limited is based in Sydney, Australia

APPENDIX B: SENSITIVITY OF MONKHOUSE FORMULA TO PARAMETER ESTIMATES

We note in section 6.2.1 that the Monkhouse formula can be written as

$$\beta a = \frac{\beta e + \beta d \cdot X}{1 + X}$$

where

$$X = \left[1 - \left(\frac{rd}{1 + rd} \right) (1 - \gamma) Te \right] \frac{D}{E}$$

In this appendix we show that within a reasonable range the assumptions about rd, γ, and Te do not have a material impact on the calculation of the asset beta.

The bounds on the term in square brackets can be estimated by setting appropriate parameter values. The term $rd/(1+rd)$ will equal zero if rd =0 but will be a positive value if rd > 0. If rd = 5% then $rd/(1+rd)$ = 0.0476, and if rd = 15% then $rd/(1+rd)$ = 0.1304. It seems unlikely that a firm would have a cost of debt that falls outside of these bounds. The value of γ is discussed in section 5.2. Our view is that γ lies broadly between 0 and 0.5. We approximate the effective tax rate Te as being equal to the corporate tax rate, which is 30% in Australia, but could easily range between 20% and 40%. Given these parameters, the upper bound for the term in square brackets is [1 – 0.0476 x (1 – 0.5) x 20%] = 0.9952. The lower bound for the term in square brackets is [1 – 0.1304 x (1 – 0) x 40%] = 0.9478.

If debt is 20% of capital structure then D/E = 0.25, and X has an upper bound of 0.2488 and a lower bound of 0.2365. Assuming, for this example, a debt beta of zero, the asset beta will range between 0.8008 and 0.8087. For an equity beta equal to 1, the choice of parameters within the ranges described can alter the beta by as much as 0.008. This difference is not material and is certainly a lot less than the statistical error in the estimate of the equity beta.

If debt is 80% of capital structure then D/E = 4, and X has an upper bound of 3.9808 and a lower bound of 3.7912. Assuming, for this example, a debt beta of zero, the asset beta will range between 0.2008 and 0.2087 of the equity beta. For an equity beta equal to 1, the choice of parameters again alters the asset beta by 0.008.[40]

We conclude that the choice of parameters for calculating estimates of the asset beta is not critical, so long as the parameters selected lie within a range that is likely to apply for the comparator firm.

40 If the calculations are not rounded then there is a small difference in the error that results from differences in the D/E ratio. This difference is lost in the rounding in the calculations we have presented, and is even smaller than the potential error of 0.008

APPENDIX C: BETA BIAS USING THE AUSTRALIAN INDEX

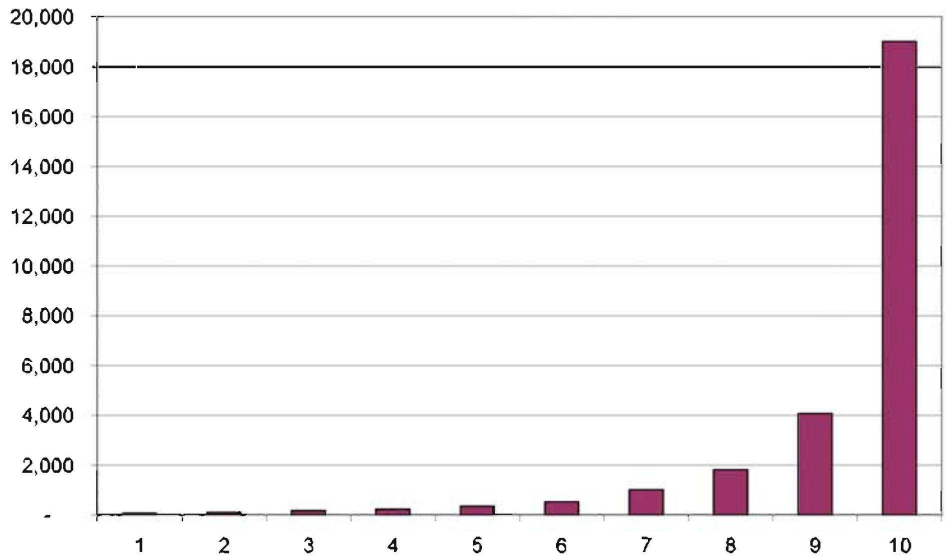
When the market value of one company (or one industry) is a significant percentage of the total market value of an index, the beta for that company (or the companies of that industry) can be substantially higher when measured against that index than they would be if measured against a broader index.

As a firm's proportion of an index increases, less of the firm's specific risks are diversified within the index. The significance of this can be demonstrated by using both mathematical intuition and by varying weights for the index and recalculating betas. The latter approach is used first below to demonstrate the dramatic effect this can have on the betas of mining stocks within the Australian stock market index. A discussion of the mathematical intuition follows. Finally, economic argument is presented to suggest that is likely that a beta measured against a broader index is more likely to reflect the expected returns of Australian mining stocks.

C.1 DEMONSTRATION OF THE IMPACT ON STOCK BETAS WHEN THEY HAVE SIGNIFICANT WEIGHTS IN THE MARKET INDEX

Figure 6 shows that market values for stocks within the Australian index are heavily skewed towards larger stocks. This is true for most exchanges but the in Australia a number of individual stocks make up large portions in their own right. In the case of the 303 stocks in our sample, the top ten firms represent nearly 50% of the total market value (see Table 17).

Figure 6: Average market value by decile (000's AU$) for the 303 Australian constituents of the Australian all ordinary index that traded from 31 Dec 2002 until 31 December 2007



Source: Average of monthly data for Dec 2002 to Dec 2007 from Datastream

Table 17: Top 10 firms by market cap and their share of the total market cap

	% of total
BHP BILLITON	8.7%
TELSTRA	6.6%
NATIONAL AUS.BANK	6.3%
COMMONWEALTH BK.OF AUS.	6.0%
AUS.AND NZ.BANKING GP.	4.9%
WESTPAC BANKING	4.5%
RIO TINTO	3.2%
WESTFIELD GROUP	2.9%
WOOLWORTHS	2.4%
WOODSIDE PETROLEUM	2.3%
Total	47.6%

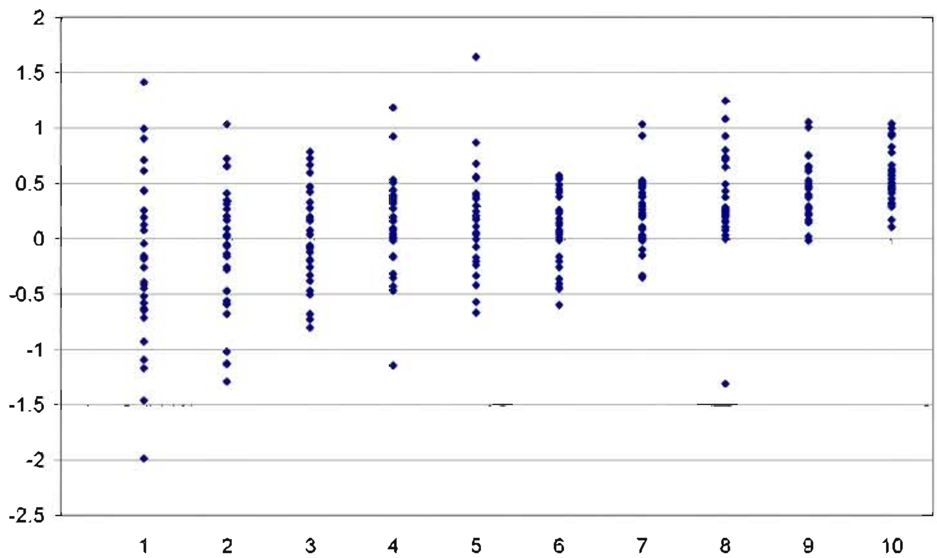
Source. Average of monthly data for Dec 2002 to Dec 2007 from Datastream

Of the largest ten firms two are mining companies and another is in the oil & gas sector. Indeed, commodity stock (i.e. metals & mining and oil & gas stocks) make up 23% of the total market capitalisation within our sample. Any commodity-specific event is not going to be diversified in the way in which it would in a broader index.

The significance of this can be demonstrated by comparing the beta of the stocks in our sample when measured against the actual index and the beta of each stock when measured against an equally weighted index (which serves as a proxy for a broader index).

The difference between the betas using market and equal weights is presented in Figure 7 with the results organised by decile. The difference for firms of all sizes can be significant, but for the largest firms (those in the 10th decile) the difference is always positive.

Figure 7: The difference between market weighted and equally weighted betas for the 3003 firms in our sample organised by market cap deciles



Source: CRA calculations based on monthly data for Dec 2002 to Dec 2007 from Datastream

Table 18: Top 10 mining firms and the difference between their market weighted and equally weighted betas

	Beta relative to actual index	Beta relative to equally weighted index	Difference
BHP BILLITON	1.72	0.92	0.93
RIO TINTO	1.23	0.75	0.54
ALUMINA	1.29	0.84	0.50
NEWCREST MINING	1.97	1.16	1.00
BLUESCOPE STEEL	1.55	1.14	0.50
COAL & ALLD.INDS.	-0.00	-0.01	-0.02
LIHIR GOLD	2.05	1.50	0.65
CSR	1.52	0.77	0.75
OZ MINERALS	1.99	1.76	0.28
FORTESCUE METALS GP.	3.02	2.44	1.24

Source. CRA calculations based on monthly data for Dec 2002 to Dec 2007 from Datastream

Table 18 presents the betas and their differences for the largest 10 mining stocks. Clearly the impact on BHP Billiton, Rio Tinto and FMG is dramatic and the use of an Australian index has a substantial impact on the beta.

C.2 Mathematical intuition

Betas are formally the covariance of a stock and the market divided by the variance of the market. Standard practice involves calculating betas by regressing the returns of each stock against the returns on the market. That is:

$$\delta y = \alpha + \beta \delta Mo + \varepsilon$$

Where:

δy = the row vector that represents the excess returns for an individual stock.

δMo = the row vector that represents the excess returns for the market.

β = the beta on the market for that stock

However, assuming a weight for each stock that is constant over the period, the betas for every stock in an index can be estimated with one equation. That is:

$$\beta = \frac{C\omega}{\omega' C\omega}$$

Where:

β = a column vector of the betas that are applicable for each stock;

w = a column vector of weights within the index for each stock (these add to 1).

C = the covariance matrix for the stocks in the index.

The numerator in this equation is of specific interest as the denominator is the variance of the index (and thereafter the same for all stocks). For each stock **Cw** is equivalent to obtaining the sumproduct of: (1) the market weights (***w***); and (2) the applicable column from ***C***. For each stock, therefore, the beta will include the product of its own variance and its own weight in the index. Since the own variance factor is likely to be higher than the covariance factors within a given column, the product of the variance and a firm's weight in the index will have a significant effect on the beta of a stock – especially where a stock has a substantial weight within the index.

C.3 Economic intuition

If we were to assume that mining investors were all Australian and all of their investments were in Australia then they would expect to be rewarded for all the undiversifiable risks associated with mining. In that case, the expected return should reflect the beta as measured against the market weighted Australian index.

However, this is clearly not the case. There are significant foreign investors in Australian mining stocks. To consider the impact they might have on the expected returns in Australian mining companies it is useful to start from the proposition that the Australian market is *initially* closed to foreign investors and Australians cannot invest abroad but then these restrictions are lifted. Initially, the expected returns of the mining companies will have been a function of the beta measured against the local market . However, these higher returns will represent significant excess returns when measured by foreign investors against their own diversified portfolios. As such, they will be prepared to bid up the price of Australian mining shares until the returns become of function of their own broader portfolios.

Australian investors will then invest abroad in order to maintain a well diversified portfolio, selling Australian mining shares and acquiring others which increase the diversification of their own portfolios.

In most cases this process will not be entirely complete. Transaction and search costs will limit both Australian and foreign investors. However, where these mining stocks are listed and well followed both in Australia and abroad, it is reasonable to expect that the beta of Australian stocks when measured against and broad index will give a significantly more accurate estimate of the expected returns on those stocks than betas measured against the narrow Australia index.