Attachment 2: Frontier Economics Independent Expert Report on Asset Beta and Equity Beta

Estimates of asset beta and equity beta for Queensland Rail

REPORT PREPARED FOR QUEENSLAND RAIL

July 2018

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1 Executive summary

1 Frontier Economics has been retained by Queensland Rail to provide an estimate of the asset and equity beta parameters for its network; such parameters most notably impact the reference tariff applied to the West Moreton coal network.

1.1 Key findings

2 Our primary conclusions are as follows:

a. The relevant comparators for Queensland Rail's network are likely to differ substantially from those used for Aurizon's Central Queensland Coal Network because of fundamental differences in the nature of risk between the two networks.

b. Regulated energy and water firms should not be used as comparators for the Queensland Rail network as regulation has a minor impact on the relevant asset beta of a regulated firm.

c. The first principles methodology of Incenta (2017), as adopted by the Queensland Competition Authority (QCA) in the 2017 Draft Access Undertaking for Aurizon Network, does not indicate that regulated energy and water businesses are suitable comparators for the Queensland Rail Network.

d. The appropriate asset beta, based on comparators in the ports, railroads, airports and toll roads industries, is determined to be 0.77 when applying a methodology consistent with that accepted by the QCA.

e. Applying a benchmark gearing of 28%, obtained in a manner consistent with the asset beta estimate, yields an equity beta of 0.98 under standard QCA assumptions regarding debt beta and gamma.

1.2 Author of report

3 This report has been authored by Professor Stephen Gray, Professor of Finance at the UQ Business School, University of Queensland and Director of Frontier Economics, a specialist economics and corporate finance consultancy. I have Honours degrees in Commerce and Law from the University of Queensland and a PhD in Financial Economics from Stanford University. I teach graduate level courses with a focus on cost of capital issues, I have published widely in high-level academic journals, and I have more than 20 years' experience advising regulators, government agencies and regulated businesses on cost of capital issues. I have published a number of papers that specifically address beta estimation issues. A copy of my curriculum vitae is attached as an appendix to this report.

4 My opinions set out in this report are based on the specialist knowledge acquired from my training and experience set out above. I have been provided with a copy of the Federal Court's Expert Evidence Practice Note GPN-EXPT, which comprises the guidelines for expert witnesses in the Federal Court of Australia. I have read, understood and complied with the Practice Note and the Harmonised Expert Witness Code of Conduct that is attached to it and agree to be bound by them.

5 I have been assisted in the preparation of this report by Dinesh Kumareswaran, Warwick Davis and James Key from Frontier Economics.

2 Features of Queensland Rail network

6 While the Queensland Rail network may superficially appear to have similarities with the Aurizon Central Queensland Coal Network (Aurizon Network), the two networks have fundamentally different risk profiles. Consequently, the approach and the resulting beta estimate for Aurizon Network is not appropriate for the Queensland Rail Network.

7 In selecting comparators to use in estimating the asset beta of the Queensland Rail network, the relevant risk characteristics are of paramount importance. Our view is that the services provided by Queensland Rail network indicate that, ideally, comparators would have the following characteristics:

- **Be a transport infrastructure operator**: Most of Queensland Rail's network operations are as a below rail infrastructure supplier to above rail shippers and mines.[1]
- **Be used to transport a mix of bulk freight and other kinds of freight**: West Moreton and Mt Isa ship bulk freight with smaller amounts of non-bulk freight. QR also provides passenger services.
- **Have a reasonably small number of larger customers**: Queensland Rail's customers include coal mines, Aurizon and Queensland Government for passenger rail.
- **Be exposed to competition in some or all components of the business**: the Queensland Rail network is subject to significant competition on non-coal traffic from road. Freight transport between cities on the east coast of Queensland, as far north as Cairns, in particular is exposed to competition with both road transport and sea transport.
- **Be exposed to changes in demand from changes in global commodity prices**: Queensland Rail's coal customers are highly exposed to changes in commodity markets given the relatively low value (and consequently low margin) nature of the coal produced in West Moreton, and the relatively high below and above rail costs of transport from this region.

8 While these characteristics should guide the selection and use of comparator entities to estimate key WACC parameters (such as the asset beta and gearing), few comparators, if any, will embody *all* of these ideal characteristics. Therefore, trade-offs between elements of comparability must be made in selecting comparators. Comparators should be selected and afforded weight on the extent to which their

1 As previously stated by Frontier, the firm's industry is at least one relevant criteria for analysis, DAU 2017, p92.

asset beta reflects conditions relevant to Queensland Rail in contrast to alternative comparators.

9 In Table 1 below we provide a high level comparison between firms operating in different industry sectors which could potentially be useful comparators for Queensland Rail.

10 This analysis indicates that other railroads, and ports, are likely to be the closest comparators to Queensland Rail, with airports next closest. The pipeline and toll road sectors are somewhat less comparable. The regulated electricity and water sector are least comparable, sharing no key risk-based features with Queensland Rail. A key variable which can differ between comparators is the degree of competition which each faces; in some instances firms have very strong market power (such as the only port in a major city), whereas in some instances competition is more evident (such as major ports in Europe, where there are a number of larger competing ports).

Table 1: Assessment of relevant comparators for Queensland Rail

Queensland Rail attribute	Class 1 Railroads#	Ports	Airports	Pipelines	Tollroads	Electricity / Water
Transport infrastructure operator	✓	✓	✓	✗	✓	✗
Mix of bulk freight / freight	✓	✓	✗	✗	✗	✗
Small number of customers	✓	✓	✗	✓	✗	✗
Exposed to non-trivial competition	Varies	Varies	Varies	Varies	Varies	✗
Exposed to demand change from global markets	✓	✓	✓	✗	✗	✗

Source: Frontier Economics analysis.
Notes: # Revenues more than $USD100 million.

11 The form of regulation can have an effect on the degree of systematic risk, but it is only one of a number of more minor factors.[2] The relevance of particular forms of regulation must be considered on a case by case basis.

2 Frontier does not consider regulation to substantially impact beta estimates, see Aurizon DAU 2017, p. 92.

12 In the 2014 Draft Decision for Queensland Rail, the QCA proposed an equity beta of 0.8, equal to the figure that the QCA had adopted for Aurizon Network, and equal to that proposed by Queensland Rail in its submission. In that decision, the asset beta was set to 0.45 and gearing was set to 55%. At the time of the 2014 Draft Decision, the QCA stated that:

> To date, the QCA has not received submissions to suggest Queensland Rail's business risks are lower than those of Aurizon Network.[3]

13 However, in its 2015 Draft Access Undertaking, Queensland Rail submitted that it was likely to be subject to greater systematic risk than Aurizon Network, noting that the 2014 Draft Decision highlighted several key differences between Queensland Rail and Aurizon Network: Price versus revenue cap regulation, service diversification and sources of revenue. However, Queensland Rail proposed to maintain the same asset beta, equal to that of Aurizon Network and the QCA accepted Queensland Rail's proposal.

14 More recently, the QCA has commissioned Incenta to estimate appropriate asset and equity betas for Aurizon Network. Incenta (2017) has concluded that the beta estimates for Aurizon Network should be based entirely on data from regulated energy and water businesses on the basis that such businesses are most comparable (in terms of systematic risk) to Aurizon Network.[4] It is our view that such businesses would not serve as ideal comparators for Queensland Rail because of the material differences between the risk characteristics of Aurizon Network and Queensland Rail.

2.1 Comparator industries

2.1.1 Class 1 railroads

15 Our view is that the best systematic risk comparators for Queensland Rail are Class 1 railroads.[5] Incenta (2017) did not afford any weight to this industry in estimating the asset beta for Aurizon Network, citing the following:

> Class 1 railroads are expected to have materially higher systematic risk than Aurizon Network. Class 1 railroads are subject to competitive pressure from parallel railroads and alternative transport modes; carry loads that are highly sensitivity to GDP shocks; have relatively higher operating leverage; and their cash flows are neither constrained nor buffered by regulation, which merely monitors the rate of return being earned.[6]

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3 Queensland Rail DAU 2013, p143.

4 Using a 10-year window, taking the average asset beta obtained using of weekly and monthly series. See Incenta (2017), p. 78.

5 Those with revenues greater than $USD100 million annually.

6 Incenta (2017), page 43.

16 However, as noted above, Queensland Rail *is* subject to competitive pressure on a number of freight routes, competing against both road and sea transport. This is not the case for all routes: approximately [redacted] of revenue is attributable to bulk freight, which would arguably not be contestable with road.[7] Coal transported from West Moreton would not be economical to move by truck, and accounts for approximately [redacted] of revenue. Similarly, bulk products on the Mt Isa line are not considered contestable.

17 Some smaller scale projects, such as in the North West Minerals Province, have been contestable and road has been chosen over rail in some cases.[8] While the coal/bulk business may arguably be non-contestable, the non-bulk component would be contestable in many cases. In a recent report, Ranbury Management Group (2015) noted that "Rail's major point of differentiation is price, with rail generally having to significantly undercut road pricing to gain business."[9] Reasons cited for the contestability include the longer transit times, complexity, unreliability and lack of availability of rail.[10]

18 The North Coast Line appears to be subject to competition with road transportation:

> Rail has been losing market share to road freight on this corridor, a situation mirroring that happening along the east coast South–North corridor. Rail is struggling to compete with road freight transport, in an environment of a significant uplift in road vehicle productivity, and massive investment in the highway network between Melbourne and Brisbane, and now planned for Brisbane – Cairns.[11]

19 Moreover, there is considerable uncertainty regarding the sustainability of revenues associated with the coal component; the share of revenue that is contestable by road (or sea) may increase considerably during the forthcoming undertaking period.

20 Also, as noted above, Queensland Rail has a small number of customers.[12] This raises the risk profile as a large reduction in demand could result from the decisions of a single customer. The New Acland Coal mine in particular accounts for a substantial share of revenue; approximately [redacted]

7 Source: Queensland Rail.

8 Source: Queensland Rail.

9 Ranbury, North Coast Line Capacity Improvement Study — Final Report, February 2015, page 11.

10 Ranbury, North Coast Line Capacity Improvement Study — Final Report, February 2015, page 34.

11 Ranbury, North Coast Line Capacity Improvement Study — Final Report, February 2015, page 10.

12 In contrast to the large number of customers (15) using Aurizon's CQCR.

[redacted]

21 In addition, Queensland Rail *is* materially exposed to national and global shocks: the commodities transported in the West Moreton region are substantially different to those transported by Aurizon: the low margins give rise to a risk that a downturn in commodity prices leads to a reduction in demand of transportation from Queensland Rail, with mine closures plausible (as happened with Wilkie Creek in 2013).

2.1.2 Ports

22 While not considered by Incenta (2107) for Aurizon Network, ports share many similarities with railroad infrastructure such as that forming the asset base of Queensland Rail, and may be informative of Queensland Rail's asset beta.

23 While ports may differ considerably in the product composition, a mix of bulk freight and other freight would be expected for many ports in the sample. Some ports are also materially exposed to global markets through reliance on certain commodities, for example thermal coal either exported or imported.

2.1.3 Airports

24 Airports fall within the sector of transport infrastructure, and so may be informative of the risks faced by other infrastructure operators.

25 While not typically used to transport bulk freight, freight operations may contribute to airport revenue, with air cargo operations accounting for approximately 13% of commercial airline revenue in 2017.

26 The passenger transportation operations side of airports shares some similarities with that of QR, at least the long-distance passenger services are exposed to similar shocks to demand. However QR has a large share of suburban traffic; risks associated with these operations are unlikely to be related to those associated with air passenger services.

27 While some airports may have a large share of revenue accounted for by few airlines, acting as a hub, many airports might have a more diverse source of revenue. Furthermore, the demand for airport services is in most cases derived by consumer demand, with airport fees determined in part by passenger numbers. This is in contrast to the West Moreton coal transport operations of Queensland Rail, which rely on a very small number of mines.

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13 The Land Court recommended cancelling the expansion plans in 2017, though on appeal the Supreme Court rejected the decision, sending the issue back to the Land Court for further consideration. *New Acland Coal Pty Ltd v Smith & Ors* [2018] QSC 88.

28 The competition faced by airports differs considerably across airports. While some airports may possess a substantial degree of market power, with few competitors located sufficiently close, other airports may be located close to competitors and so face constraints in passenger and freight services.

29 Airports however are exposed to some degree to global markets, in particular the tourism sector, which was impacted during the global financial crisis. The degree of exposure is however uncertain, and may not fully reflect the potential impact of thermal coal demand on Queensland Rail operations.[14]

2.1.4 Pipelines

30 Pipelines in North America are considered as comparators, and share the feature of having a typical low number of customers, though are not typically considered as transportation infrastructure. Incenta (2017) noted that North American pipelines are subject to competitive pressure (though this would differ across pipelines):

> Oil and gas transmission pipelines are subject to competitive pressures from parallel pipelines and alternative transport modes. As such, in general North American pipelines lack market power and their customers are not 'captured' like the customers of Aurizon Network.[15]

31 This aspect is shared with Queensland Rail, with alternative modes of transport applying competitive pressure to some Queensland Rail operations.

32 Relevant to our approach is the exposure to global shocks. As much of the output transported in the pipelines is destined for domestic use, industrial and commercial demand, the exposure is somewhat reduced compared to that of Queensland Rail.

33 Accordingly, while these pipelines may be used to transport products that could be considered commodities, these firms are of limited use to estimating the asset beta of Queensland Rail.

2.1.5 Toll roads

34 Incenta (2017) noted that toll roads are exposed to competitive pressure from alternative routes/transportation modes. The regulation form also aligns more closely with Queensland Rail, compared to Aurizon, since price caps often apply, linked to inflation. While toll roads may be used for freight transportation, the exposure of toll roads to commodity markets is less than that of other infrastructure owners such as Queensland Rail. In addition, the number of customers is typically large and diverse.

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14 Airlines and airports disagreed on the incidence of the impact of the GFC, see "Economic Regulation of Airport Services", Productivity Commission, 2011.

15 Incenta (2017), p. 43.

35 Incenta (2017) concluded that to be sensitive to GDP shocks, bearing full demand risk with CPI rather than cost-based price regulation. Accordingly, Incenta state that the demand of residential and industrial/commercial customers is expected to "display some sensitivity to the economic cycle, since there are often alternatives to toll road services, and there is no regulatory buffer."

36 Toll roads do however relate to the passenger transportation aspect of QR, and as such are afforded some weight.

2.1.6 Regulated energy and water businesses

37 In our view, it is not appropriate to estimate the beta for Queensland Rail solely on data from regulated energy and water network businesses. We note that Queensland Rail differs from a typical energy or water network business on two key dimensions[16]:

a. Nature of customer base – the diverse nature of customer geography and demand mitigates demand risk that applies to energy and water distribution companies; and

b. Elasticity of demand for service – the lack of substitutes for an energy or water distribution company means that they are able to benefit from relatively inelastic demand.

38 As noted in Table 1 above, firms in the regulated energy and water sector are not considered to be informative comparators of Queensland Rail. Failing to reside in the broad industry of transportation infrastructure, such businesses also have very few similarities in terms of determinants of risk exposure.

39 Incenta (2017) observed that:

> Both Aurizon Network and regulated energy and water businesses are monopoly service providers, have a 'captured' customer base with resilient demand for the service, and are subject to cost-based regulation for pre-set periods that cushions cash flows. These factors result in low sensitivity of demand / revenue to GDP shocks.

However, it is important to consider the key aspects resulting in the adoption of such comparators for Aurizon: market power, resilient demand, form of regulation, and low sensitivity of revenue to shocks. These are not applicable to Queensland Rail, and so these regulated energy and water businesses would be expected to have materially lower systematic risk than Queensland Rail.

40 Forming part of the resilient demand of regulated energy and water businesses is the large number of customers: residential, commercial and industrial. Synergies (2017) noted that "electricity and water networks are characterised by large numbers of low volume customers (low customer concentration), with low

16 QCA, UT5 Draft Decision p. 109.

dependence on high volume customers for revenue."[17] This is not in line with Queensland Rail's coal customer base, which has a low number of mines with high demand.

41 Also, the demand risk of Queensland Rail's coal network is more aligned with coal prices as it relies on demand of coal both in Queensland and internationally. Given the recent volatility in the global coal markets, demand for Queensland coal is likely to be more elastic than the demand for energy provided by energy networks.[18] As Queensland Rail has a different risk profile to a typical energy distribution network, this makes companies in this sector poor comparators.

42 In addition to the demand risks referred to in Section 2.1.1 above, Queensland Rail has been subject to a number of substantial reductions in demand for access. The closure of Queensland Nickel in 2016, for example, resulted in a loss of approximately [redacted] in annual revenue.[19]

43 [redacted]

44 To reduce the stranding risk of its assets, Queensland Rail secures take-or-pay contracts, which energy and water networks do not use for residential consumers. This further leads to differences in the way Queensland Rail operates when compared to a typical energy or water distribution network. Rather, the use of these contracts makes the risk of Queensland Rail more similar to transmission pipelines such as natural gas or liquids, which have fewer customers with significant demand.

45 The QCA recognised such differences in their 2013 draft decision:

> However, the QCA notes there are also significant differences between the entities that suggest that Queensland Rail's risks are unlikely to be less than those faced by Aurizon Network. In particular, Queensland Rail:
>
> (a) is more exposed to movements in the economy as it is subject to a price cap. In contrast, Aurizon Network has revenue certainty through its revenue cap
>
> (b) obtains revenues from only two coal mines (Cameby Downs and New Acland) on the western system. In contrast, Aurizon Network's revenue is from around 50 mines and over 15 companies across the CQCR

17 QCA, UT5 Draft Decision, p. 111.

18 QCA, UT5 Draft Decision, p. 113.

19 Source: Queensland Rail.

20 See http://www.abc.net.au/news/rural/2017-02-23/more-freight-to-hit-north-queensland-roads-glencore/8296554

> (c) provides for the transport of relatively low-margin thermal coal, where one mine has recently closed (Wilkie Creek). In contrast, Aurizon Network transports a large proportion of higher-margin coking coal and its coal traffic has not traditionally been related to Australian (or Queensland) economic and stock market cycles.

46 The material differences in risk profiles between Queensland Rail and regulated energy and water leaves little reason to include regulated energy and water in the comparator sample to be used in estimating asset beta.

2.2 Comparison with Aurizon Network

47 The QCA's approach to estimating the beta for Aurizon Network is to place 100% weight on a set of regulated electricity and water businesses. The QCA considered that the primary driver of systematic risk was the form of regulation and noted that Aurizon Network and the regulated electricity and water businesses shared the same form of regulation and were therefore comparable on that basis.

48 In our view, the approach adopted for Aurizon Network should not be adopted for Queensland Rail for two primary reasons:

a. The form of regulation is only one of a number of determinants of systematic risk, and there are material differences between Queensland Rail and Aurizon Network in terms of many of the drivers of systematic risk; and

b. Even if the form of regulation is considered to be the primary driver of systematic risk, Aurizon Network operates under revenue cap regulation whereas Queensland Rail operates under price cap regulation.

49 That is, while the form of regulation differs substantially between Queensland Rail and Aurizon, many other considerations are substantially different, leading to Queensland Rail having a materially higher risk profile than Aurizon. As a consequence, there is no basis for applying the same approach to estimate beta for Queensland Rail and Aurizon Network.

50 The QCA's 2013 Draft Decision for Queensland Rail noted a number of material differences between Queensland Rail and Aurizon Network. However, the 2015 Draft Decision documented a number of similarities between the two networks:[21]

> Based on our analysis, we note that Queensland Rail's West Moreton network and Aurizon Network share similar characteristics, namely that they have:
>
> □ operations in the Queensland coal chain, although there is some difference in the composition of product

21 Queensland Rail DAU 2015, p68

- cost-based based regulation that is applied to coal traffic operations
- revenue protection from take-or-pay contract provisions
- cost pass-through provisions within access agreements
- similar institutional arrangements, in that they are both located in the same state and regulated by the same regulator.

While there are some high-level similarities in that both networks are used for transporting coal, our view is that there are a number of material differences that have implications for the degree of systematic risk. The key differences are summarised in Table 2 below.

Table 2: Comparison between Queensland Rail / Aurizon supply of services for bulk freight (coal) and non-coal

Factors affecting position of miners		Queensland Rail	Aurizon
Value and resilience of demand	Coal mine type	Thermal – lower value	Coking / Metallurgical – higher value
Cost	Network state / cost	West Moreton – older, higher cost, not originally designed for coal	CQCN – newer, designed for coal, lower cost
	Above rail cost	Below rail limits above rail efficiency e.g. TAL, length	Not limited to same degree
	Mines within relative cost curves	More marginal	Inframarginal
Diversity of revenue	Other traffic	West Moreton has other traffic types – but this is unprofitable subsidised traffic	Nil
	Mine reliance	1-3 mines – high variance	~60 mines – lower variance
Contracts		Unclear whether take or pay In 2013: While Queensland Rail is protected from under-railings by take-or-pay provisions, those only cover 80% of contracted paths.	Take or pay
Regulation		Price cap – upside and downside on volume risk	Revenue cap
Competition		WM: May be limited for coal traffic Other network: Subject to considerable road-rail competition. Bulk freight	Nil

	favours rail. See Ranbury, p. 104.	

Source: Frontier Economics analysis.

51 In our view, the differences set out in Table 2 have significant implications for systematic risk. Although both networks transport coal, there are many factors which make them dissimilar.

52 Three key differences are:

a. The CQCN services more mature coal mines than Queensland Rail regional system;

b. Smaller amounts of coal are transported using the Queensland Rail regional system than the CQCN;

c. More shippers use the CQCN.

53 We consider that "industry characteristics, customer concentration, and exposure to a particular type of customer also matter for risk."[22] Since Aurizon Network's customers consist of more mature coal mines compared to those serviced by Queensland Rail,[23] this will lead to a different beta.

54 Both Aurizon Network and Frontier have previously considered that "regulation, at most, is just one of the many dimensions that should be considered in determining the appropriate comparator businesses"[24], implying that based on regulation alone Aurizon Network and Queensland Rail are not directly comparable.[25]

55 QCA's consultant Incenta noted that "the underlying economic aspects of Aurizon Network (e.g., certainty of demand and long-term take-or-pay contracts) imply recovery of regulated revenues".[26] However, Queensland Rail does not have this certainty of demand due to the more volatile quantities of coal being mined and transported than compared to Aurizon Network.

56 Since Incenta believe "that regulated energy and water businesses are the best available comparators at this time to estimate Aurizon Network's systematic risk"[27], and Queensland Rail is dissimilar enough to Aurizon, energy networks are not a good comparator for Queensland Rail. These points lead Frontier to believe that, at minimum, other industries should be included to estimate Queensland

22 QCA, UT5 Draft Decision, p. 91.

23 Typically lower value thermal coal.

24 QCA, UT5 Draft Decision, p. 91.

25 QCA, UT5 Draft Decision, p. 92.

26 QCA, UT4 Final Decision p. 248.

27 QCA, UT5 Draft Decision, p. 110.

Rail's beta, rather than simply adopting the same beta as that which is used for Aurizon Network.

3 Estimation of asset beta

57 As illustrated in Table 1 above, it is our view that the relevant comparator industries include railways, ports, toll roads and airports. We consider that these comparator firms all provide potentially relevant information. It is our view that inclusion of comparators in the (revenue cap) regulated energy and water sector will not improve the accuracy of the asset beta estimate for Queensland Rail because the only reason to include those firms is on the basis of their form of regulation and:

a. Regulation is only one of a number of factors that affect systematic risk; and

b. Because Queensland Rail and Aurizon operate under a different form of regulation, comparators that are appropriate for Aurizon will not be appropriate for Queensland Rail.

58 In contrast to Aurizon, which shares revenue cap regulation with many of these comparators, Queensland Rail is subject to price cap regulation. In the absence of this consideration, regulated energy and water businesses should not be considered informative of the systemic risk to which Queensland Rail is exposed.

59 In this section we outline the method through which we estimate the asset betas of comparator industries, and accordingly the asset and equity betas of Queensland Rail.

3.1 Asset beta estimation method

60 For each potential comparator we obtained from Bloomberg the equity betas for the period May 2008 through to April 2018, and for the period May 2013 through to April 2018; this allows estimation of asset betas over a 5-year and 10-year window. We note that these time periods are consistent with the analysis performed by Incenta (2017).

61 For each window we obtain raw equity betas at both the weekly and monthly frequency, as both of these frequencies are commonly used and have been applied by regulators including QCA.[28]

62 Following the standard QCA approach as adopted by Incenta (2017), we de-lever the raw equity betas using gearing estimated as the average value of net debt over market capitalization over the relevant period. We also follow the standard QCA approach in using a debt beta of 0.12, the QCA's current gamma estimate of 0.46 and the prevailing statutory tax rate for each comparator firm.

[28] Incenta (2017), p. 73, and DAU 2017, p. 90.

63 The following expression relates the equity, asset and debt betas (β_e, β_a and β_d respectively), where T is the corporate tax rate (adjusted for imputation by multiplying the statutory tax rate by 1-γ where relevant), D is net debt and E is market capitalization:

$$\beta_e = \beta_a\left(1 + (1-T)\frac{D}{E}\right) - \beta_d(1-T)\frac{D}{E}.$$

64 The above Conine formula, generally adopted by the QCA, was used to obtain asset betas for each comparator, for each of the four estimated raw equity betas (two time periods and two data frequencies). Results for each industry are summarized below in Table 3, showing average asset betas for each industry for the four different windows/frequencies. The range and midpoint refers to the industry average, not to individual comparator betas.

65 The comparators used for each industry are presented in Section 72. These comparators expand on those used by Incenta (2017), with additional categories of ports and airports.

66 For the ports industry, the original set of potential comparators contained 78 firms. Due to the large number of comparators, a filtering process was applied to remove those asset betas that would be less informative for purely econometric reasons. This was done on the basis of the standard error of the raw beta estimates (removed if one or more of the equity beta estimates had a standard error greater than 0.3), and the Amihud illiquidity measure (removed if greater than 6×10^{-7}). This leaves 39 comparator firms, suitable for estimation of the asset beta of ports.[29]

29 This filtering process had limited impact on the midpoint asset beta of the ports comparator group; the midpoint of the unfiltered sample was 0.026 points lower than the filtered sample, while having a substantially higher range for the averages of the four windows/frequencies.

Table 3: Calculated asset betas for Queensland Rail comparators

Industry	Count	10 years 2013-05 to 2018-04		5 years 2008-05 to 2018-04		Range low	Range high	Midpoint
		Weekly	Monthly	Weekly	Monthly			
Airports	25	0.73	0.73	0.68	0.76	0.68	0.76	0.72
Gas & liquids pipelines	15	0.81	0.70	0.71	0.48	0.48	0.81	0.64
Class 1 Railways	12	0.89	0.84	0.88	0.96	0.84	0.96	0.90
Ports	39	0.68	0.72	0.72	0.81	0.68	0.81	0.74
Regulated Energy and Water	78	0.41	0.31	0.45	0.34	0.31	0.45	0.38
Toll roads	8	0.49	0.56	0.51	0.54	0.49	0.56	0.53

Source: Frontier Economics analysis of Bloomberg data using QCA de-levering approach and QCA parameter values.

67 As noted above, it is our view that the asset betas of the airports, Class 1 railways, toll roads and ports are the most informative of the conditions and risks faced by Queensland Rail. Comparators in the regulated energy and water industry do not share key characteristics with Queensland Rail; neither do comparators in the pipeline sector. The toll roads and airports sectors both fall in the transport infrastructure industry, with airports in particular exposed to demand changes from global markets. Class 1 railways (annual revenues greater than $USD100 million) and ports are judged to be close comparators to Queensland Rail; they receive the most weight.

Table 4: Weights applied to industry segments

Industry	Weight
Airports	15%
Gas & liquids pipelines	0%
Class 1 railways	40%
Ports	30%
Regulated Energy and Water	0%
Toll roads	15%

Source: Frontier Economics analysis.

68 Applying the weights set out in Table 4 to the midpoint asset beta estimates of each comparator industry yields an asset beta estimate of 0.77.

4 Estimation of equity beta

69 The equity beta is estimated by re-levering the asset beta estimate of 0.77 according to the QCA's Conine approach. As in the de-levering step above, debt beta and gamma are taken to be 0.12 and 0.46 respectively (standard QCA assumptions), and the relevant statutory tax rate is used (30% in the case of Queensland Rail).

70 The net debt/market capitalization ratio used in the Conine formula is taken from the comparators, applying the same weighting as used for the asset beta calculations to the average gearing, across comparators, in each industry. The midpoint of the 5-year and 10-year average figures is used, as set out in Table 5 below.

Table 5: Debt/Equity ratio for comparator industries

Industry	Weight	Midpoint gearing
Airports	15%	0.35
Gas & liquids pipelines	0%	0.61
Class 1 railways	40%	0.26
Ports	30%	0.34
Regulated Energy and Water	0%	0.71
Tollroads	15%	0.85
Weighted average		**0.39**

Source: Frontier Economics analysis of Bloomberg data using QCA de-levering approach and QCA parameter values.

71 Thus, applying the weights as used for the asset beta to industry averages of net debt over market capitalization produces a gearing estimate of 0.39. This corresponds to a gearing ratio (the ratio of net debt to net debt plus market value of equity) of 28 per cent. This is adopted as the benchmark capital structure to be used in obtaining an equity beta of Queensland Rail, and is consistent with the approach taken to obtain the asset beta, specifically the weightings applied to each of the potential comparator industries and the approach of taking the midpoint of estimates from different windows/frequencies.[30] A summary of the relevant parameter estimates is set out in Table 6 below.

30 Frequency is not relevant for gearing as the data is averaged over the time period examined.

Table 6: Queensland Rail indicative cost of capital parameters

Parameter	Value
Asset beta	0.77
Gearing	0.28
Debt beta	0.12
Gamma	0.46
Equity beta	0.98

Source: Frontier Economics analysis of Bloomberg data.

72 We note that a 28% gearing figure is materially below the 55% figure that the QCA has adopted in recent decisions for both Queensland Rail and Aurizon. However, a lower level of gearing is consistent with a higher degree of systematic risk – other things being equal, riskier assets are able to support relatively less debt. Thus, whereas our analysis indicates that a higher asset beta is warranted for Queensland Rail, the impact of that change is mitigated by the lower level of gearing such that the resulting change in equity beta is more limited (from 0.8 to 0.98).

5 Sensitivity analysis

73 The equity beta is estimated by re-levering the asset beta estimate of 0.77 according to the QCA's Conine approach. As in the de-levering step above, debt beta and gamma are taken to be 0.12 and 0.46 respectively (standard QCA assumptions), and the relevant statutory tax rate is used (30% in the case of Queensland Rail).

74 Our beta and gearing estimates are based on the weights assigned to each set of comparators as set out in Table 4 above. Whereas we have explained the rationale for the weights we have selected (being based on the risk characteristics summarised in Table 1), we recognise that a degree of judgment is required. In relation to the application of that judgment, we make the following points:

a. We consider that the relative weights should be based on more than the form of regulation. Regulation is only one of a number of factors that determines a firm's systematic risk.

b. Queensland Rail operates under a different form of regulation than Aurizon Network and regulated electricity and water businesses. It also has a number of other characteristics that make it unlike regulated electricity and water businesses in terms of systematic risk.

c. An asset beta estimate as low as that adopted by the QCA for Aurizon Network can only be maintained if 100% weight is applied to regulated electricity and water businesses. If any material weight is applied to any other group of comparators, the result would be a higher asset beta estimate.

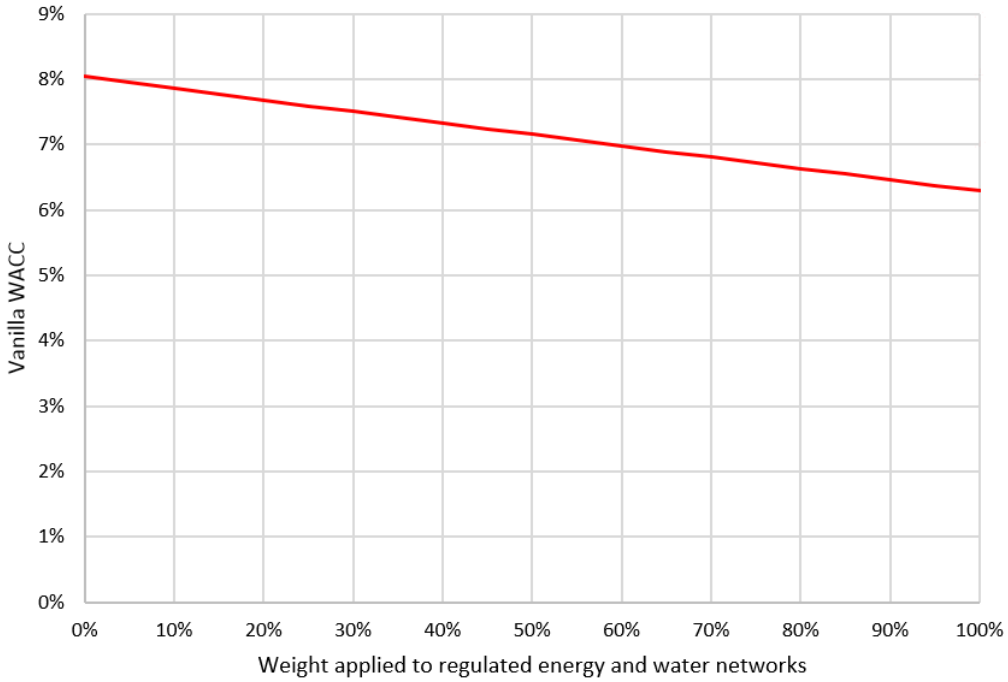
d. Changing the weights in Table 4 to afford more weight to the regulated electricity and water businesses would have two effects that somewhat offset each other:

    i. It would lower the asset beta estimate as more weight is applied to the industry segment that involves the lowest level of systematic risk; and

    ii. It would increase the gearing estimate as more weight is applied to the industry segment that (because of its lower risk) is able to support relatively more debt.

75 The sensitivity of the vanilla WACC estimate to different weights applied to the regulated energy and water sample is summarised in below. In all cases we adopt a return on debt of 4.5%, a risk-free rate of 2.5% and a market risk premium of 7%. The 0% weight corresponds to our recommended estimate, which uses comparators from other industries. The 100% weight applies the QCA's Aurizon Network Draft Decision, with an asset beta of 0.45 and gearing of 55%, based on energy and water network businesses.

Figure 1: Vanilla WACC sensitivity to weight applied to energy and water network comparators.



Source: Frontier Economics analysis. Return on debt set to 4.5%, risk-free rate set to 2.5%, MRP set to 7%.

6 Appendix: Industry samples used in estimation of asset and equity betas

Table 7: Class 1 Railways

Company name	Ticker	Country
Canadian National Railway	CNR CN Equity	Canada
Canadian Pacific Railway Ltd	CP CN Equity	Canada
Asciano Limited	AIO AU Equity	Australia
Aurizon Holdings Ltd	AZJ AU Equity	Australia
Daqin Railway Co Ltd	601006 CH Equity	China
Genessee & Wyoming	GWR US Equity	USA
Container Corporation of India Ltd	CCRI IN Equity	India
Globaltrans Investment PLC	GLTR LI Equity	Russia
CSX Corporation	CSX US Equity	USA
Kansas City Southern	KSU US Equity	USA
Norfolk Southern Corp	NSC US Equity	USA
Union Pacific Railroad	UNP US Equity	USA

Source: Incenta and Frontier Economics.

Table 8: Tollroads

Company name	Ticker	Country
Abertis Infrastructuras	ABE SM Equity	Spain
ASTM SpA	AT IM Equity	Italy
Atlantia SpA	ATL IM Equity	Italy
Getlink (Groupe Eurotunnel)	GET FP Equity	France
Societa Iniziative Autostradali e Servizi	SIS IM Equity	Italy
Transurban Group	TCL AU Equity	Australia
Macquaire Atlas Roads	ALX AU Equity	Australia

Vinci SA	DG FP Equity	France

Source: Incenta and Frontier Economics.

Table 9: Pipelines

Company name	Ticker	Country
Boardwalk Pipeline Partners LP	BWP US Equity	USA
EQT Midstream Partners LP	EQT US Equity	USA
Spectra Energy Corp	SEP US Equity	USA
TC PipeLines LP	TCP US Equity	USA
Williams Partners LP	WPZ US Equity	USA
Kinder Morgan Inc/DE	KMI US Equity	USA
Buckeye Partners LP	BPL US Equity	USA
Enbridge Energy Partners LP	EEP US Equity	USA
Enterprise Products Partners LP	EPD US Equity	USA
Magellan Midstream Partners LP	MMP US Equity	USA
Plains All American Pipeline	PAA US Equity	USA
Sunoco Logistics Partners LP	ETP US Equity	USA
ONEOK Inc	OKE US Equity	USA
Enbridge Inc	ENB CN Equity	Canada
TransCanada Corporation	TRP US Equity	USA

Source: Incenta.

Table 10: Airports

Company name	Ticker	Country
Aerodrom Nikola Tesla Beograd	AERO SG Equity	Serbia
Airport Facilities Co Ltd	8864 JP Equity	Japan
Airports of Thailand	AOT TB Equity	Thailand
Auckland International Airport	AIA NZ Equity	NZ
Beijing Capital International Airport Co Ltd	694 HK Equity	Hong Kong

Copenhagen Airport	KBHL DC Equity	Denmark
Frankfurt Airport Services Worldwide	FRA GR Equity	Germany
GMR Infrastructure Ltd	GMRI IN Equity	India
Grupo Aeropurtuario del Centro Norte SAB de CV	OMAB MM Equity	Mexico
Grupo Aeroportuario del Pacifico SAB de CV	GAPB MM Equity	Mexico
Grupo Aeroportuario del Sureste	ASURB MM Equity	Mexico
Guangzhou Baiyun International Airport Co Ltd	600004 CH Equity	China
HNA Infrastructure Co Ltd	357 HK Equity	Hong Kong
Japan Airport Terminal Co Ltd	9706 JP Equity	Japan
Malaysia Airport Holdings Bhd	MAHB MK Equity	Malaysia
Paris Airport	ADP FP Equity	France
SAVE SpA/Venezia	SAVE IM Equity	Italy
Shenzhen Airport Co Ltd	000089 CH Equity	China
Shanghai International Airport Co Ltd	600009 CH Equity	China
Sydney Airport	SYD AU Equity	Australia
TAV Havalimanlari Holding AS	TAVHL TI Equity	Turkey
Toscana Aeroporti SpA	TYA IM Equity	Italy
Vienna International Airport	FLU AV Equity	Austria
Xiamen International Airport Co Ltd	600897 CH Equity	China
Zurich Airport International	FHZN SE Equity	Switzerland

Source: Frontier Economics.

Table 11: Ports

Company name	Ticker	Country
Adani Ports & Special Economic Zone Ltd	ADSEZ IN Equity	India
China Merchants Port Holdings	144 HK Equity	Hong Kong
COSCO SHIPPING Ports Ltd	1199 HK Equity	Hong Kong
DP World Ltd	DPW DU Equity	Dubai

Hamburger Hafen und Logistik	HHFA GR Equity	Germany
Hutchison Port Holdings Trust	HPHT SP Equity	Singapore
International Container Terminal Services	ICT PM Equity	Philippines
Port of Tauranga Ltd	POT NZ Equity	NZ
Shanghai International Port Gr	600018 CH Equity	China
Shenzhen Chiwan Wharf Holdings Ltd	200022 CH Equity	China
Sociedad Matriz SAAM SA	SMSAAM CI Equity	Chile
Tianjin Port Co Ltd	600717 CH Equity	China
Tianjin Port Development Holdings Ltd	3382 HK Equity	Hong Kong
Wilson Sons Ltd	WSON33 BZ Equity	Brazil
Pakistan International Contain	PICT PA Equity	Pakistan
DP World Ltd	DPW DU Equity	Dubai
Puerto Ventanas SA	VENTANA CI Equity	Chile
Ningbo Zhoushan Port Co Ltd	601018 CH Equity	China
Qingdao Port International Co	6198 HK Equity	Hong Kong
TangShan Port Group Co Ltd	601000 CH Equity	China
Qinhuangdao Port Co Ltd	3369 HK Equity	Hong Kong
Rizhao Port Co Ltd	600017 CH Equity	China
Yingkou Port Liability Co Ltd	600317 CH Equity	China
Beibuwan Port Co Ltd	000582 CH Equity	China
Jinzhou Port Co Ltd	900952 CH Equity	China
Shenzhen Chiwan Wharf Holdings	200022 CH Equity	China
Zhuhai Port Co Ltd	000507 CH Equity	China
Jiangsu Lianyungang Port Co Lt	601008 CH Equity	China
Gemadept Corp	GMD VN Equity	Vietnam
Rinko Corp	9355 JP Equity	Japan
Puertos y Logistica SA	PUERTO CI Equity	Chile

China Container Terminal Corp	2613 TT Equity	Taiwan
Portuaria Cabo Froward SA	FROWARD CI Equity	Chile
Gold Bond Group Ltd/The	GOLD IT Equity	Israel
Nanjing Port Co Ltd	002040 CH Equity	China
Zhuhai Winbase International C	002492 CH Equity	China
Dinh Vu Port Investment & Development	DVP VN Equity	Vietnam
Dong Nai Port JSC	PDN VN Equity	Vietnam
Doan Xa Port JSC	DXP VN Equity	Vietnam

Source: Frontier Economics

Table 12: Regulated Energy and Water

Company name	Ticker	Country
ALLETE Inc	ALE US Equity	USA
Alliant Energy Corp	LNT US Equity	USA
Ameren Corp	AEE US Equity	USA
American Electric Power Co Inc	AEP US Equity	USA
APA Group	APA AU Equity	Australia
Atco Ltd/Canada	ACO/X CN Equity	Canada
Atmos Energy Corp	ATO US Equity	USA
AusNet Services	AST AU Equity	Australia
Avista Corp	AVA US Equity	USA
Black Hills Corp	BKH US Equity	USA
Canadian Utilities Ltd	CU CN Equity	Canada
CenterPoint Energy Inc	CNP US Equity	USA
Centrica	CNA LN Equity	UK
Chesapeake Utilities Corp	CPK US Equity	USA
CMS Energy Corp	CMS US Equity	USA
Consolidated Edison Inc	ED US Equity	USA

Delta Natural Gas Co Inc	DGAS US Equity	USA
Dominion Resources Inc/VA	D US Equity	USA
DTE Energy Co	DTE US Equity	USA
DUET Group	DUE AU Equity	Australia
Duke Energy Corp	DUK US Equity	USA
Edison International	EIX US Equity	USA
El Paso Electric Co	EE US Equity	USA
Emera Inc	EMA CN Equity	Canada
Empire District Electric Co/The	EDE US Equity	USA
Entergy Corp	ETR US Equity	USA
Eversource Energy	ES US Equity	USA
Exelon Corp	EXC US Equity	USA
FirstEnergy Corp	FE US Equity	USA
Fortis Inc/Canada	FTS CN Equity	Canada
Great Plains Energy Inc	GXP US Equity	USA
Hawaiian Electric Industries Inc	HE US Equity	USA
IDACORP Inc	IDA US Equity	USA
MGE Energy Inc	MGEE US Equity	USA
National Fuel Gas Co	NFG US Equity	USA
National Grid PLC	NG/ LN Equity	UK
New Jersey Resources Corp	NJR US Equity	USA
NextEra Energy Inc	NEE US Equity	USA
NiSource Inc	NI US Equity	USA
Northwest Natural Gas Co	NWN US Equity	USA
NorthWestern Corp	NWE US Equity	USA
OGE Energy Corp	OGE US Equity	USA
Otter Tail Corp	OTTR US Equity	USA

PG&E Corp	PCG US Equity	USA
Pinnacle West Capital Corp	PNW US Equity	USA
PNM Resources Inc	PNM US Equity	USA
Portland General Electric Co	POR US Equity	USA
PPL Corp	PPL US Equity	USA
Public Service Enterprise Group	PEG US Equity	USA
SCANA Corp	SCG US Equity	USA
Sempra Energy	SRE US Equity	USA
South Jersey Industries Inc	SJI US Equity	USA
Southwest Gas Corp	SWX US Equity	USA
Spark Infrastructure Group	SKI AU Equity	Australia
Spire Inc	SR US Equity	USA
SSE PLC	SSE LN Equity	UK
Southern Co/The	SO US Equity	USA
TransCanada Corporation	TRP CN Equity	Canada
UGI Corp	UGI US Equity	USA
United Utilities Group PLC	UU/ LN Equity	UK
Unitil Corp	UTL US Equity	USA
Vector Ltd	VCT NZ Equity	NZ
Vectren Corp	VVC US Equity	USA
WEC Energy Group Inc	WEC US Equity	USA
Westar Energy Inc	WR US Equity	USA
WGL Holdings Inc	WGL US Equity	USA
Xcel Energy Inc	XEL US Equity	USA
American States Water Company	AWR US Equity	USA
American Water Works Company	AWK US Equity	USA
Aqua America Inc	WTR US Equity	USA

Artesian Resources Company	ARTNA US Equity	USA
California Water Service Group	CWT US Equity	USA
Connecticut Water Service Inc	CTWS US Equity	USA
Middlesex Water Company	MSEX US Equity	USA
Pennon Group PLC	PNN LN Equity	UK
Severn Trent PLC	SVT LN Equity	UK
SJW Corporation	SJW US Equity	USA
The York Water Company	YORW US Equity	USA

Source: Incenta.

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