

# DISCOUNT RATE AND ANALYSIS PERIOD

A technical paper prepared for the Investment Decision-Making Framework Review

27 NOVEMBER 2019

Waka Kotahi NZ Transport Agency has revised the discount rate used in cost benefit analysis from 6% to 4%. This change increases the analysis period to 60 years, from the current 40-year time period. Guidance recommends that scenario testing at 6% and 3% is carried out.

This change makes the quality of demand forecasting even more important. It also increases the need for a range of options and scenarios to be developed, and for reporting on distribution and uncertainty in business cases and economic evaluation. Part of the new Monetised Benefits and Costs Manual (MBCM), these changes will apply from 1 July 2020.

## An important note for the reader

Waka Kotahi NZ Transport Agency is a Crown entity established under the Land Transport Management Act 2003. The objective of Waka Kotahi is to undertake its functions in a way that contributes to an efficient, effective and safe land transport system in the public interest.

Technical papers are commissioned as part of the Waka Kotahi core function in developing and providing advice to deliver the objectives for Waka Kotahi set out in the Land Transport Management Act 2003. They include work undertaken by Waka Kotahi staff as well as work undertaken for Waka Kotahi by external researchers or consultants.

While this technical report is believed to be correct at the time of preparation, Waka Kotahi and agents involved in its preparation and publication do not accept any liability for use of the report. People using the technical report, whether directly or indirectly, should apply and rely on their own skill and judgement. They should not rely on the contents of the technical report in isolation from other sources of advice and information. If necessary, they should seek appropriate legal or other expert advice.

Waka Kotahi takes no responsibility for any errors, omissions in, or for the correctness of, the information contained in these papers.

### Abbreviations and acronyms

BCR	Benefit-cost ratio
CAPM	Capital asset pricing model
CBA	Cost-benefit analysis
CPI	Consumers price index
EEM	Economic evaluation manual (a Waka Kotahi publication)
ERP	Equity risk premium
GNP	Gross national product
LTMA	Land Transport Management Act 2003
NPV	Net present value
PV	Present value
SOC	Social opportunity cost
WACC	Weighted average cost of capital

## Contents

EXECUTIVE SUMMARY.....	4
ABSTRACT .....	5
THE WAKA KOTAHI NZ TRANSPORT AGENCY DISCOUNT RATE – 2019 .....	6
<b>Tax and inflation</b> .....	<b>6</b>
<b>Equity Risk Premium</b> .....	<b>6</b>
<b>Risk Free Rate</b> .....	<b>7</b>
<b>Waka Kotahi asset beta</b> .....	<b>8</b>
CONCLUSION .....	9
REFERENCES.....	10
APPENDIX: DISCOUNT RATE SCENARIOS .....	11

## EXECUTIVE SUMMARY

The Waka Kotahi Economic evaluation manual (EEM) utilises social cost-benefit analysis, or CBA for short, as a method of evaluating the added benefits and costs over time to the whole of society from an initiative or set of initiatives. The EEM seeks to assess the overall benefit to society and to guide the prioritisation of the initiatives and others by evaluating the pros and cons of each action for all of society's stakeholders relative to the status quo.

This document reviews the current methodology and assumptions that are employed to determine the discount rate for use in the EEM.

The methodology used continues the framework set out in the technical note The Discount Rate for the Economic Evaluation Manual 2013.<sup>1</sup> The methodology remains consistent with the New Zealand Treasury guidance on Public Sector Discount Rates for Cost Benefit Analysis<sup>2</sup> whilst the resulting recommended discount rate is different due to primarily a differing framework for determining the asset beta for transport.

Assumptions used by the CAPM – tax, inflation, equity risk premium (ERP), risk free rate (RFR) and asset beta ( $\beta_a$ ) – are reviewed and, where appropriate, updated to reflect current economic literature and the latest market values. As the ERP and asset beta are not directly observable for Waka Kotahi, these assumptions are considered in detail identifying ranges of possible assumptions based on different methodologies for the ERP and proxies for the asset beta.

The range from positive and negative changes to all assumptions are 5.33% to 1.96% for the period to end of June 2019.

The key changes from the discount rate of 6% set in 2013 are:

- Risk Free Rate 2.0% (previously 5.0%)
- CPI 2.0% (previously 2.5%).

After allowing for taxation and risk, the remaining factors are ERP (range 3.6%–7%) and asset beta (range 0.2–0.4).

A baseline discount rate of 4% has been estimated. Scenario testing at 3% and 6% is recommended reflecting the range of rates obtainable under different plausible assumptions for the ERP and asset beta. The rate is based on an ERP of 7% and asset beta of 0.4.

### *Caution required*

Benefit cost analysis is an important tool but not a substitute for judgement. The use of cost-benefit analyses is important in guiding the efficient allocation of public investment. However, it is not a panacea, and considered judgement and thorough documentation of the assumptions is important.

Sensitivity analysis is recommended, not just on the discount rate but also on the benefits and costs of the proposed project. Discount rates are fundamentally a mechanism to connect the future with the present. To the extent that the future is uncertain, and perceptions of future developments are reflected in today's expectations, then it is unreasonable to expect that there would ever be a single approach or a single discount rate that would meet with universal acceptance. Careful professional judgement, sensitivity analysis and transparent documentation available for public scrutiny are all required.

---

<sup>1</sup> NZ Transport Agency, New Zealand (2013) The Discount rate for the Economic Evaluation Manual (Wellington: New Zealand Government) <https://www.nzta.govt.nz/assets/planning/investment/docs/research-paper-on-discount-rate-revisions.pdf>

<sup>2</sup> Treasury, New Zealand (2008) Public sector discount rates for cost benefit analysis (Wellington: New Zealand Government)

<http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/discountrates>

## ABSTRACT

This paper reviews the methodology for the calculation of the discount rate for cost–benefit analysis in the Waka Kotahi Economic Evaluation Manual, utilising a Social Opportunity Cost framework based on the Capital Asset Pricing Model (CAPM). This methodology is consistent with the New Zealand Treasury guidance on Public Sector Discount Rates for Cost Benefit Analysis<sup>3</sup>, whilst the resulting recommended discount rate is different due to primarily a differing framework for determining the asset beta for transport.

Assumptions used by the CAPM – tax, inflation, Equity Risk Premium (ERP), Risk Free Rate (RFR) and asset beta ( $\beta_a$ ) – are reviewed and, where appropriate, updated to reflect current economic literature and the latest market values. As the ERP and asset beta are not directly observable for Waka Kotahi, these assumptions are considered in detail identifying ranges of possible assumptions based on different methodologies for the ERP and proxies for the asset beta.

A baseline rate of 4% has been estimated. This rate is based on an average ERP of 7% and asset beta of 0.4.

Scenario testing at 3% and 6% is recommended reflecting the range of rates obtainable under different plausible assumptions for the ERP and asset beta.

---

<sup>3</sup> Treasury, New Zealand (2008) Public sector discount rates for cost benefit analysis (Wellington: New Zealand Government)  
<http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/discountrates>

# THE WAKA KOTAHI NZ TRANSPORT AGENCY

## DISCOUNT RATE – 2019

This section reviews the assumptions for the discount rate calculation for Waka Kotahi. Particular attention is given to the two factors that are not readily observable, the equity risk premium (ERP) and asset beta ( $\beta_a$ ), by establishing a range of plausible ERPs and a framework for establishing the appropriate asset class for Waka Kotahi and then a range of proxy beta to estimate the Waka Kotahi asset beta.

### Tax and inflation

For the Waka Kotahi discount rate values for corporate and effective tax rate are based on current tax rules:

- Corporate tax rate – 28%
- Effective tax rate – 24%.

Inflation is based on average CPI, noting that the rate of inflation over the medium term is within the Reserve Bank of New Zealand (RBNZ) policy target agreement, where the policy target shall be to keep future CPI inflation outcomes between 1 per cent and 3 percent on average over the medium term, with a focus on keeping future average inflation near the 2 per cent target midpoint<sup>4</sup>. For the Waka Kotahi discount rate the RBNZ midpoint target of 2.0% is recommended, noting that at the date of publication the specific rate could be higher or lower.

Therefore, the recommended values for corporate tax, effective tax and inflation are:

- |                                       |       |
|---------------------------------------|-------|
| • T <sub>c</sub> (corporate tax rate) | 28%   |
| • T <sub>e</sub> (effective tax rate) | 24%   |
| • I (inflation rate)                  | 2.0%. |

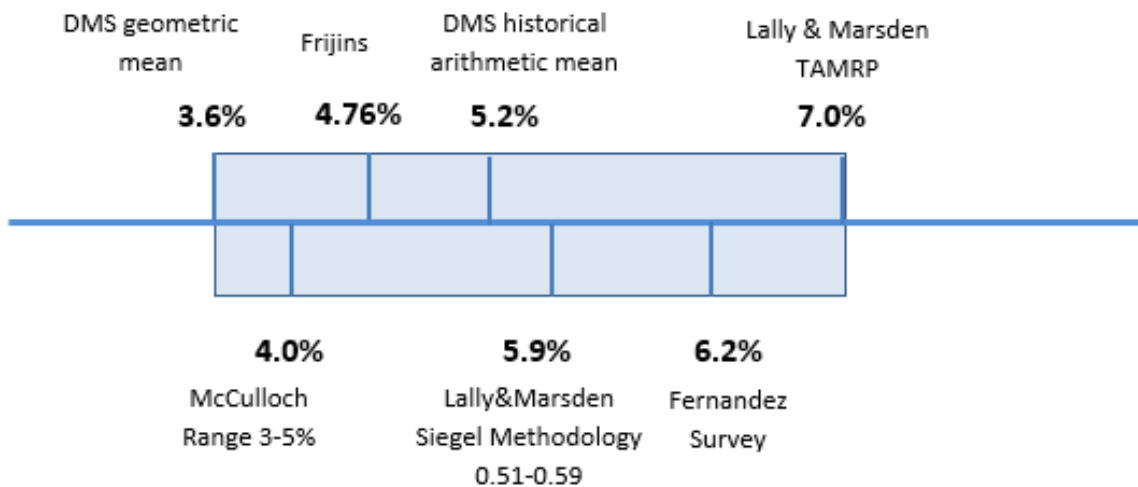
### Equity Risk Premium

The Equity Risk Premium (ERP – also referred to as Market Equity Risk Premium) remains unchanged at 7% in line with the 2013 assessment. The estimates of plausible ERP have been updated to include analysis by Frijns (2016) reviewing the period 1899-2013 (updated to 2016) arriving at an ERP of 4.76%.

There are various methods to estimate the ERP and each has its own strengths and weaknesses. They also generate a wide range of results, some of which are summarised in figure 1 below:

---

<sup>4</sup> RBNZ Policy Target Agreement renewed <https://www.rbnz.govt.nz/news/2017/11/renewed-policy-targets-agreement-signed>



**Figure 1: Summary of ERP estimates<sup>5</sup>**

Frijns (2016) further notes the importance of the time period for data selection and illustrates this by reviewing the ERP used the 10-year period 2006 to 2016 to show we can be 95% confident the ERP will be in the range of -7.67% to 13.69%. Using the full 117-year sample and a 95% confidence interval, the lower and upper bounds of the ERP fall to 1.31% to 8.20%.

Information from Reserve Bank of Australia (RBA)<sup>6</sup> in a review of the Australian Equity Market for the period 1917 to 2019 indicates that the Australian ERP is likely to be lower than previously estimated with an ERP of 4%.

The 2017 Credit Suisse Global Investment Returns Sourcebook identifies the equity risk premium over long term government bonds for New Zealand of; 2.9% for the period 1967 to 2016, and 4.0 for the period 1900-2016.

This range of plausible estimates of the ERP are considered in scenario testing of the discount rate in the attached appendix, noting that the recommended 7% may represent an upper estimate with lower estimates of the ERP resulting in a lower discount rate.

## Risk Free Rate

The Risk Free Rate (RFR) uses the New Zealand government 10-year bond rates as a proxy for the 'risk free' rate of interest. The 10-year NZ government bond to the period at the close of the June financial year was 1.57<sup>7</sup>.

A range of scenarios of the 10-year bond across time periods are set out below:

<sup>5</sup> Sources:

Geometric mean - Dimson, Marsh Stauton Credit Suisse Global Investment Returns Sourcebook, 2012, Credit Suisse/ London Business School;

Arithmetic mean - Dimson, Marsh Stauton Credit Suisse Global Investment Returns Sourcebook, 2012, Credit Suisse/ London Business School;

McCulloch range: McCulloch B and Leonova D, 2005. The Market Equity Risk Premium, New Zealand Treasury working paper;

Frijns B and Tourani-Rad A., (2016) The long-run performance of the New Zealand stock markets: 1899-2013. Updated to 2016.

Lally and Marsden TAMRP - Lally & Marsden 2002, Historical Market Risk Premiums in New Zealand: 1931- 2000;

Lally and Marsden Siegel Methodology - Lally, M and Marsden, A., (2005) Estimating the Market Risk Premium in New Zealand through the Siegel Methodology; and

Fernandez Survey - Pablo Fernandez, Javier Aguirreamalloa and Luis Corres, 2011, Market Risk Premium used in 56 countries in 2011

<sup>6</sup> Mathews T, 2019. 'A History of Australian Equities', RBA Research Discussion Paper No 2019-04. Available at <https://www.rba.gov.au/publications/rdp/2019/2019-04.html>

<sup>7</sup> RBNZ Statistics Wholesale interest rates – B2 <https://www.rbnz.govt.nz/statistics/b2>. Note 28 June was last day of daily trading for June month.

**Table 1: 10-year bond; 6 month, 1-, 2- and 3-year averages-**

6 month	1.98
1 year	2.30
2 years	2.59
3 year	2.68

Source: RBNZ historical Wholesale Interest Rates – B2 Monthly close (June 2019)<sup>8</sup>. Author's calculation.

The period up to end of June 2019 included a daily low for the 10-year bond of 1.51<sup>9</sup>. The 6-month average is 2.0% (rounded) using both the daily and monthly 10-year bond series from the RBNZ.

Whilst rates may still move higher or lower, a RFR of 2.0% is selected as the assumption for the discount rate. Scenario testing of higher and lower ranges for the RFR and other variables is included in the appendix.

## **Waka Kotahi asset beta**

Noting the previous analysis of the asset beta for Waka Kotahi in the 2013 working paper and the ongoing characteristics of Waka Kotahi, in particular as a regulated monopoly network with low exposure to GNP shocks, an asset beta estimate range of 0.2–0.4 remains appropriate. The asset beta for the discount is 0.4. Scenario testing is included in the appendix.

---

<sup>8</sup> Ibid

<sup>9</sup> Ibid 24 June 2019



## CONCLUSION

Based on the analysis outlined in this paper, a discount rate of 4% (rounded) is recommended for the Waka Kotahi EEM, using the Social Opportunity Cost methodology where key assumptions are a New Zealand Equity Risk Premium of 7% and a Waka Kotahi asset beta of 0.4. Utilising the lowest estimates for equity risk premium (3.6%) and asset beta of 0.3 would generate a discount rate of 1.0% (rounded).

It should be noted that many of the issues surrounding the correct choice of the discount rate are still to be resolved and it should be expected that over time the methodology and choice of the discount rate will be revisited in light of new information.

### *Caution required*

Benefit cost analysis is an important tool but not a substitute for judgement. The use of cost-benefit analyses is important in guiding the efficient allocation of public investment. However, it is not a panacea, and considered judgement and thorough documentation of the assumptions is important.

Sensitivity analysis is recommended, not just on the discount rate but also on the benefits and costs of the proposed project. Discount rates are fundamentally a mechanism to connect the future with the present. To the extent that the future is uncertain, and perceptions of future developments are reflected in today's expectations, then it is unreasonable to expect that there would ever be a single approach or a single discount rate that would meet with universal acceptance. Careful professional judgement, sensitivity analysis and transparent documentation available for public scrutiny are all required.

**Table 2: Discount rate formula and results**

$$WACC \text{ (real)} = [(1 + WACCn) / (1 + i)]^{-1}$$

where:

$$WACCn = [RFR \times (1 - T_c) + (E_p \times \beta_a)] / (1 - T_e)$$

Tc (corporate tax rate)	Tc	28%	28%	28%
Te (effective tax rate)	Te	24%	24%	24%
Ep (equity risk premium)	Ep	7%	7%	7%
RFR (risk free rate)	RFR	2%	2%	2%
i (inflation rate)	i	2.0%	2.0%	2.0%
asset beta	$\beta_a$	0.4	0.3	0.2
<hr/>				
WACCn		5.58%	4.66%	3.74%
WACC real		3.51%	2.61%	1.70%
Recommended Waka Kotahi discount rate		<b>4.00%</b>		

## REFERENCES

Dimson, E., Marsh, P. and Staunton, M., 2012 Credit Suisse Global Investment Returns Yearbook 2012, Credit Suisse

Dimson, E., Marsh, P. and Staunton, M., 2017 Credit Suisse Global Investment Returns Yearbook 2017, Credit Suisse

Fernandez, Pablo, Aguirreamalloa, Javier and Avendaño, Luis Corres, Market Risk Premium Used in 82 Countries in 2012: A Survey with 7,192 Answers (January 29, 2013). Available at SSRN: <http://ssrn.com/abstract=2084213> or <http://dx.doi.org/10.2139/ssrn.2084213>

Bart Frijns and Alireza Tourani-Rad (2016) "The long-run performance of the New Zealand stock markets: 1899-2013", Pacific Accounting Review, Vol. 28 No. 1, pp. 59-70

Lally M, 1998. Transfund New Zealand, July 1998, Estimating Transfund's Asset Beta

Lally, M and Marsden, A., 2002 Historical Market Risk Premiums in New Zealand: 1931- 2000, [http://www.nzfc.ac.nz/archives/2003/pdf/Lally\\_Marsden.pdf](http://www.nzfc.ac.nz/archives/2003/pdf/Lally_Marsden.pdf)

Lally, M and Marsden, A., (2005) Estimating the Market Risk Premium in New Zealand through the Siegel Methodology. Accounting Research Journal, Vol. 17 No. 2 (2004), pp. 93-101.

Available at <http://www.nzfc.ac.nz/archives/2004/Papers/docs/Lally%20and%20Marsden.pdf>

Mathews T, 2019. 'A History of Australian Equities', RBA Research Discussion Paper No 2019-04. Available at <https://www.rba.gov.au/publications/rdp/2019/2019-04.html>

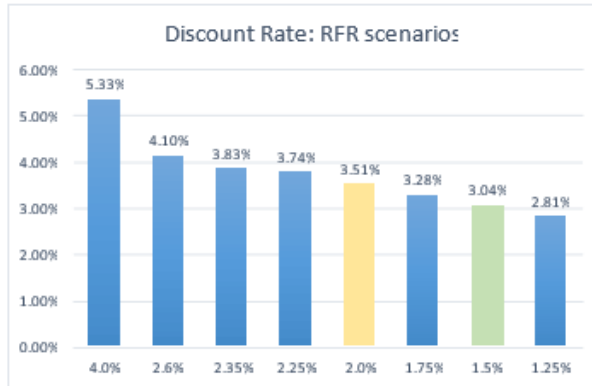
McCulloch B and Leonova D, 2005. The Market Equity Risk Premium, New Zealand Treasury working paper. Available at <http://www.treasury.govt.nz/publications/research-policy/tp/merp/tp-merp-may2005.pdf>

RBNZ 2017, Policy Target Agreement <https://www.rbnz.govt.nz/news/2017/11/renewed-policy-targets-agreement-signed>

# APPENDIX: DISCOUNT RATE SCENARIOS

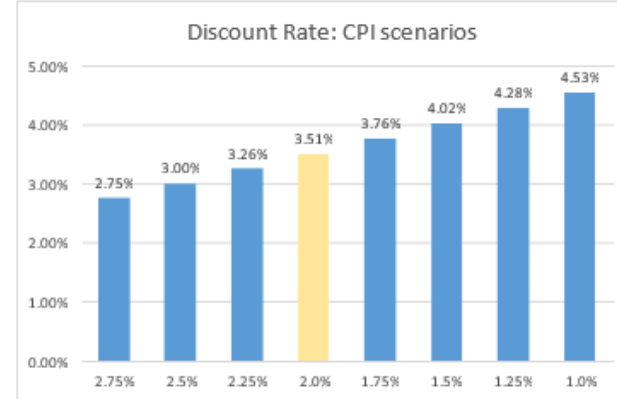
**Table 1: DR RFR Scenarios**

Beta 0.4	
RFR	DR
4.0%	5.33%
2.6%	4.10%
2.35%	3.83%
2.25%	3.74%
2.0%	3.51%
1.75%	3.28%
1.5%	3.04%
1.25%	2.81%



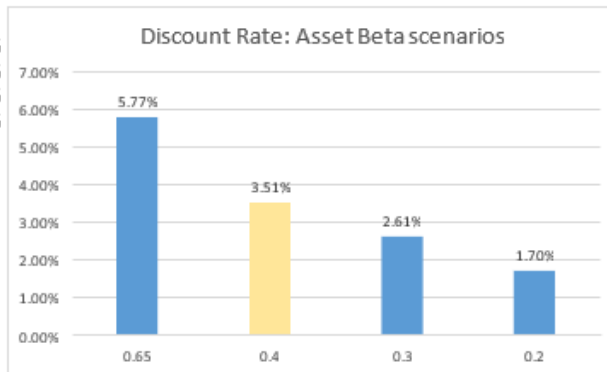
**Table 2: DR CPI Scenarios**

Beta 0.4	
CPI	DR
2.75%	2.75%
2.5%	3.00%
2.25%	3.26%
2.0%	3.51%
1.75%	3.76%
1.5%	4.02%
1.25%	4.28%
1.0%	4.53%



**Table 3: DR Asset beta Scenarios**

Beta	DR
0.65	5.77%
0.4	3.51%
0.3	2.61%
0.2	1.70%



**Table 4: DR Equity Risk Premium scenarios**

Beta 0.4	
ERP	DR
7%	3.51%
5%	2.48%
4.76%	2.35%
4.5%	2.22%
4%	1.96%

