COMPETITION ECONOMISTS GROUP

Use of Black's simple discount rule in regulatory proceedings

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1 Executive summary

1. Black's Rule provides an alternative method of deriving the NPV of a project's cash flows. Unlike the CAPM approach, which discounts the expected cash flows of the project based on the cost of capital, Black's Rule first converts those cash flows into their certainty equivalents before discounting them based on the risk-free rate.

2. In contrast to the CAPM approach, which discounts future cash flows using an estimated rate of return that accounts for the risks associated with those cash flows, Black's Rule first converts the future cash flows into their risk-free/certainty equivalents and then discounts them using the risk-free rate.

3. Loderer *et al* (2008) proposed a method for implementing Black's Rule that calculates the risk-free percentile relative to the returns of a benchmark series, and obtains certainty equivalent cash flows by applying that same percentile to the cash flows of the candidate project.

4. Loderer's approach was adopted by IWA (2015), who suggested that the method could be used as a cross-check against the Commission's Maximum Allowed Revenue determination. In turn, HoustonKemp (2015) identified an error in IWA's findings, and further argued that Black's Rule would not serve as a suitable cross-check due to various issues such information intensity and difficulty in verifying or interpreting results.

5. We have reviewed the reports by Loderer *et al* (2008), IWA (2015), and HoustonKemp (2015). We concur with HoustonKemp's correction of IWA's methodology, and have also carried out further evaluation of the analysis carried out by Loderer and IWA.

6. In particular, Loderer's implementation of Black's Rule suffers from the following drawbacks if it is to be applied to New Zealand regulated businesses:

   - The S&P 500 index as the chosen benchmark security does not have a high correlation with three quarter of the firms in the Compustat sample;
   - The international risk-free percentiles were estimated for a list of countries that did not include New Zealand;
   - The future net cash flows are assumed to be normally distributed, which does not accord with the asymmetric costs of regulated businesses;
   - The future net cash flows are estimated based on managerial estimates, and are assumed to be free of idiosyncratic sources of variation;
   - No attempt was made to establish the accuracy of managerial estimates of future net cash flows; and

- Managerial estimates tend to be opaque and subjective, which does not accord with the methodological transparency that is emphasised in regulatory decisions.

7. IWA's application of Loderer's method for the Transpower decision is also subjected to the following additional shortcomings:

   - The S&P 500 index was selected as the benchmark security without testing for correlation against Transpower's cash flows – most likely because no data was available;
   - US Treasury bills were used for calculating the risk-free percentile instead of using New Zealand data;
   - Future NCFs were assumed to be normally distributed and were derived from arbitrary estimates of pessimistic cash flows; and
   - Inconsistent use of risk-free rates when calculating risk-free percentiles and when discounting the certainty equivalent cash flows.

8. Two further observations should be noted about IWA's conclusions. First, IWA's conclusion that the MAR NCFs materially exceeded the Black's Rule certainty equivalent NCFs is incorrectly based on a comparison of the undiscounted cash flow streams. Correctly discounting the cash flow streams results in a narrower gap in NCFs.

9. Second, IWA's interpretation of the low NCF obtained from Black's Rule is problematic because a low certainty equivalent value implies that the correct discount rate is high (i.e., that there is a high risk premium associated with the cash flow). The lower the certainty equivalent value as a proportion of the risky cash flow implies the cash-flow is more risky, not less.

10. In summary, notwithstanding issues regarding the appropriateness of IWA's use of US data, our overall view is that it would be difficult to implement Black's Rule in the context of regulatory decisions. This is because Loderer's *et al* (2008) implementation is predicated on assumptions that do not necessarily hold in general and specifically in the context of regulated natural monopolies, such as the existence of a closely correlated benchmark series and normally distributed future cash flows.

11. In addition, unlike the CAPM model, where relative risk is typically estimated using long historical series of publicly available market data, Black's Rule will need to be implemented using individual-specific forecasts that may be subjective in nature. While such an approach might be appropriate if the NPV estimates are used for internal decision-making purposes within the organisation itself, it would generally be less useful for regulatory purposes in which greater emphasis is placed on transparency.

2 Introduction

12. The Capital Asset Pricing Model (CAPM) is a commonly used estimate of the cost of capital associated with a project's net cash flows (NCF).[1] The resulting cost of capital estimate can then be used to derive the net present value (NPV) of the project.

13. Loderer *et al* (2008) points out, however, that the implementation of CAPM involves identifying the market portfolio, obtaining a measure of relative risk (beta), and computing market risk premiums. Loderer therefore turns to an alternative valuation rule formulated by Black (1988), which he claims avoids some of the problems of the CAPM.

14. Briefly, Black's Rule converts the NCFs of a project to conditional expected (mean) NCFs – conditional on the benchmark return being equal to the risk-free rate.[2] In effect, the project NCFs are converted to their risk-free or "certainty equivalents", which then allows the project NPV to be calculated by discounting these "certainty equivalent" cash flows according to the risk-free rate.

15. The difficulty in applying Black's Rule lies in the calculation of these conditional mean NCFs, and Loderer's *et al* (2008) primary contribution to the academic literature is in its setting out a feasible methodology for the calculation of these conditional mean NCFs based on a number of assumptions. Loderer *et al* (2008) also provide an illustration of their methodology based on US data.

16. Ireland, Wallace & Associates (2015),[3] in a review for MEUG, suggest the use of Black's Rule as a cross check on the IM cost of capital. In their review, IWA replicate the results of Loderer's *et al* (2008) example, and demonstrate using a simple example as to how the methodology could be applied to Transpower's IM decision.

17. The primary purpose of IWA's report appears to be a demonstration of the feasibility of Black's Rule, as opposed to drawing conclusive inferences about the Commission's decision. We note, however, that IWA appears to suggest that the Maximum Allowed Revenue of the Commission's determination "materially exceed" the ones derived from Black's Rule.[4]

18. HoustonKemp (2015) identified an error in IWA's report, and show that when the error is corrected, the difference between the Commission's estimates and the

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1 Loderer cites Graham and Harvey's (2001) survey, in which 74% of managers always or almost always used the CAPM.

2 Black, A simple discounting rule, *Financial Management*, 1988, 17, pg 7-11.

3 Henceforth referred to as "IWA".

4 IWA, Input Methodology Review: "Black's Simple Discount Rule" a cross check on the IM Cost of Capital for Major Electricity Users' Group, August 2015, pg 7.

Black's Rule estimates shrink considerably.[5] In addition, HoustonKemp argue that the information requirements of Black's Rule are also fairly onerous, to the point that an assessment based on Black's Rule is unlikely to be useful to the Commission. Aside from these observations, HoustonKemp did not assess how IWA had arrived at its assessment of the "certainty equivalent" cash flows, or the validity of IWA's estimates.

19. We have reviewed the reports by Loderer *et al* (2008), IWA (2015), and HoustonKemp (2015). We concur with HoustonKemp's correction of IWA's methodology, and further examine IWA's assessment of the "certainty equivalent" cash flows.

20. Although Black's Rule is theoretically interesting, and could provide an alternative to the CAPM in certain data-rich environments, our overall view is that it would be very difficult to implement in practice and in the context of regulation. This is because Loderer's *et al* (2008) example is predicated on assumptions that do not necessarily hold in the context of regulated natural monopolies.

21. In addition, unlike the CAPM model, where relative risk is typically estimated using long historical series of publicly available market data, Black's Rule will need to be implemented using individual-specific forecasts that may be subjective in nature. While such an approach might be appropriate if the NPV estimates are used for internal decision-making purposes within the organisation itself, it would generally be less useful for regulatory purposes in which greater emphasis is placed on transparency.

5 HoustonKemp, Comment on Select Submissions to the Commission's Input Methodologies Review: A report for Powerco, September 2015.

3 Black's Rule and Loderer's *et al* (2008) implementation

22. Black's Rule provides an alternative method of deriving the NPV of a project's cash flows. Unlike the CAPM approach, which discounts the expected cash flows of the project based on the cost of capital, Black's Rule first converts those cash flows into their certainty equivalents before discounting them based on the risk-free rate.

23. As was identified by Loderer *et al* (2008), the latter approach avoids the need to estimate a number of variables, such as identifying the market portfolio, measuring risk, and computing market risk premiums. Unfortunately, Black's Rule replaces these variables with a project's future mean net cash flows conditional on a selected benchmark asset having a return equal to the risk free rate.[6] These new variables are unlikely to be easier to estimate compared to the standard CAPM parameters.

24. Loderer proposed an implementation of Black's Rule using the following five steps:[7]

    i. Find a benchmark security or index that closely correlates with the project's NCFs with an independent error term with zero mean;

    ii. Estimate the probabilities of non-positive excess benchmark returns over periods between now and project cash flows;

    iii. Obtain information from managers to assess the corresponding percentiles in the cash flow distribution (the so-called conditional mean cash flows); and

    iv. Assume that the percentiles identified in step (iii) represent the expected return on the asset conditional on the benchmark asset identified in step (i) having a return equal to the risk free rate;

    v. Discount those cash flows at the risk-free rate.

25. The first step involves identifying a benchmark series that closely correlates with the project's NCFs, such that the distribution of its historical returns are a good proxy for the future project NCFs. The second step is equivalent to calculating the percentile at which the benchmark return is equal to the risk-free rate (Loderer suggests using historical return series as a proxy for this).

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6 Loderer, Long and Roth, Black's Simple Discounting Rule, *Bradley Policy Research Center: Financial Research and Policy*, Working Paper No. FR 08-25, August 2008.

7 Loderer, Long and Roth, Black's Simple Discounting Rule, *Bradley Policy Research Center: Financial Research and Policy*, Working Paper No. FR 08-25, August 2008, pg 2. (Loderer lists four steps but we have inserted an additional step at iv to make clear that there is an assumption underpinning the last step rather than it following mathematically from the first three.

26. The third step involves identifying the distribution of future project NCFs, and calculating the level of NCFs at the percentile estimated in the second step. The fourth step is to assume that this represents the conditional mean cash flows at which the benchmark NCF is equal to the risk-free rate. Put another way, this is analogous to assuming that the value of the risky project NCF at that percentile is the same as the value of a risk free payment of the same amount ('certainty equivalent').

27. In the fifth step, the "certainty equivalent" cash flows are discounted by the risk-free rate to obtain the project NPV as estimated by Black's Rule.

28. The key assumption reflected in the above steps is set out at step (iv). The work that this assumption is doing is it allows the move from step (ii) to step (iii) to have meaning. Specifically, it is assumed that the probability of obtaining non-positive excess returns in the benchmark series is the same as the probability of obtaining non-positive excess returns in the project cash flows. In other words, it is assumed that the percentile at which the risk-free rate is positioned on the benchmark return distribution (calculated in step (ii)) is equal to the percentile at which the risk-free/certainty equivalent cash flows would be positioned on the project cash flows (calculated in step (iii)).

29. The following two examples illustrate Loderer's *et al* (2008) approach.

3.1 Simple example of Loderer's approach – uniform distribution

30. As a simple example, consider a project whose cash flows are uniformly distributed between 0 and 100. Assume that there is a benchmark series with returns historically known to be uniformly distributed between 5% and 10%, and that the historical risk-free rate is 6%, while the current risk-free rate is 2%. This fulfils the information requirements in step (i).

31. For step (ii), we calculate the risk-free percentile of the benchmark series. In this case, since the benchmark returns are uniform between 5 and 10, the historical risk-free rate of 6 is at the 20^{th} percentile of the historical benchmark returns.

32. For step (iii), we calculate the 20^{th} percentile of the project returns, as calculated in step (ii). Since the project returns are uniformly distributed between 0 and 100, the 20th percentile of the project is 20.

33. In step (iv) we assume that this is the expected value of the cash flows when the benchmark asset (identified in step (i)) has a return equal to the risk free rate. This is the 'certainty equivalent' value of the cash-flows.

34. Finally, step (v) takes the project's risk-free cash flow of 20 and discounts it by the current risk-free rate of 2%.

35. In contrast, the CAPM approach involves estimating the CAPM return for the project and then discounting the expected project cash flows (50 in this case) using said CAPM return.

3.2 Loderer's example

36. Loderer *et al* (2008) provided an illustration of Black's rule using the following parameters for a hypothetical project:

a. Starting cost of $1.2 million;

b. Constant market return of 11.39% per annum for the next 5 years;

c. Market standard deviation of 15.58% in the first year, which grows by a factor of $T^{0.5}$ at each year T;

d. Expected yearly cash flows (50th percentile or median):

i. $500 000

ii. $700 000

iii. $700 000

iv. $500 000

v. $200 000

e. Pessimistic cash flows (10th percentile):

i. $200 000

ii. $300 000

iii. $300 000

iv. $200 000

v. $100 000

f. Historical risk-free rates:

i. 5.13% for one-year tenor

ii. 5.24% for two-year tenor

iii. 5.32% for three-year tenor

iv. 5.39% for four-year tenor

v. 5.47% for five-year tenor

g. Current risk-free rates:

i. 5.25% for one-year tenor

ii. 5.30% for two-year tenor

iii. 5.45% for three-year tenor

iv. 5.50% for four-year tenor

v. 5.60% for five-year tenor

37. Based on the above information, the following market data is obtained.

Table 1: Risk-free percentiles in Loderer's *et al* (2008) example

Year	Ave R_M = 11.39*year	Stdev R_M = 15.58 * √year	Hist. R_f	R_f cumul = Hist. R_f * yr	R_f %ile
1	11.39	15.58	5.13	5.13	34.39%
2	22.78	22.03	5.24	10.48	28.83%
3	34.17	26.99	5.32	15.96	24.99%
4	45.56	31.16	5.39	21.56	22.06%
5	56.95	34.84	5.47	27.35	19.78%

Source: Loderer et al (2008) Appendix A

38. The final column of Table 1 calculates which percentile the historical risk-free rate stands at relative to the historical benchmark return. This is Step (ii) of the procedure.

39. The manager estimates can then be calculated as shown in Table 2.

Table 2: NCF distributions and calculations in Loderer's *et al* (2008) example

Year	Pessimist cash flow	Pess. Prob	Normal cash flow	Normal Prob	Est. Stdev	R_f %ile (from Table1)	Est. mean	Current R_f
1	200	10%	500	50%	234.09	34.39%	405.94	5.25%
2	300	10%	700	50%	312.12	28.83%	525.76	5.30%
3	300	10%	700	50%	312.12	24.99%	489.38	5.45%
4	200	10%	500	50%	234.09	22.06%	319.70	5.50%
5	100	10%	200	50%	78.03	19.78%	133.70	5.60%

Source: Loderer et al (2008) Appendix A

40. The second-to-last column of Table 2 is the assumed risk-free certainty equivalent cash flow of the project. As discussed in paragraph 28, it is assumed that the risk-free certainty equivalent can be calculated based on a percentile of the project cash flows. This percentile is assumed to be the same as the percentile at which the historical risk-free rate stands at relative to the benchmark return.

41. Finally, the NPV is calculated by discounting the estimated conditional means in Table 2 by the continuous risk-free rate.

42. A few issues can be seen from the example above regarding Loderer's implementation of Black's Rule, particularly in terms of the informational requirements and resulting assumptions. These are discussed in greater detail in Section 3.3.

3.3 Issues with Loderer's *et al* (2008) implementation of Black's Rule

3.3.1 Step (i): Benchmark security

43. Loderer's *et al* (2008) formulation of Black's Rule first requires a benchmark security whose returns are correlated with that of the investment project being considered. According to Loderer, the benchmark security could be an industry portfolio or some other security, including the firm's own stock.

44. Loderer's example set the S&P 500 as the benchmark index, while Treasury returns from the CRSP Government Bond Files were used as the risk-free rate. In order to determine whether the S&P 500 index was a suitable benchmark for investment projects in general, Loderer carried out a regression of the year-on-year difference in cash flows against excess returns and the risk-free rate:

$$NCF_t - NCF_{t-4Q} = \alpha + \beta_1 \times (\tilde{R}_M - R_F) + \beta_2 \times R_F + \tilde{\epsilon}$$

45. A high R^2 for the regression would suggest that the selected security was an appropriate benchmark for evaluating the cash flows of the project.

46. The above regression was carried out on the cash flows of all firms in the Compustat database, excluding financials. Loderer's results showed that the R^2 of regressions varied substantially across firms, and the average R^2 ranged from 0.222 for the 1-year return of a 5-year sampling window, to 0.293 for the 3-year return of a 5-year sampling window.

47. Loderer did not recommend any minimum threshold of R^2, above which the security provided an acceptable benchmark, but noted that the 90th percentiles and the 3rd quartiles of regression R^2 were "fairly sizable", ranging from 0.322 to 0.601. Therefore, Loderer seems to suggest that the S&P 500 index serves as a decent benchmark series for around one quarter of the firms in his sample.

48. We note, however, that Loderer's findings were carried out for firms in the Compustat database. Further regression analysis will need to be carried out using New Zealand data in order to affirm that the results still hold for regulated businesses in New Zealand.

3.3.2 Step (ii): Risk-free rate as a percentile of benchmark return

49. Loderer obtained certainty equivalent percentiles for different sets of estimates:

- One-month investment horizons: historical U.S. estimates;
- One-year investment horizons: historical U.S. estimates;
- Other maturities up to 10 years: historical U.S. estimates; and
- International capital markets.

50. For U.S. estimates, Loderer used the CRSP Value Weighted Index as the benchmark security and 30-day T-bills as proxies for the risk-free interest rate. No source was given for international data.

51. Loderer carried out a Wilcoxon rank-sum test and Mann-Whitney test to determine whether the distributions of excess returns for some of the estimates changed significantly over time. Loderer also carried out Shapiro-Wilk tests to determine whether the excess returns were normally distributed. The conclusions of these tests for each set of estimates is shown in Table 3.

Table 3: U.S. risk-free percentiles and statistical tests

	%ile	Stationarity	Normality
One-month U.S.	39-52; mostly 42-46	Stationary in most decades except 1966-1975	Not normally distributed. If normality is not assumed, risk-free percentile is 40%.
One-year U.S.	16-57; mostly 30-48	-	Not normally distributed, but relaxing the normality assumption does not lead to results that are significantly different.
>1-year U.S.	16-38	-	-
International markets	29-44	-	-

Source: Loderer et al (2008)

52. Loderer argues that the risk-free percentiles should be fairly similar across markets, provided capital markets were reasonably integrated. However, Loderer's empirical study only included the 10 largest stock markets as identified by the World Federation of Exchanges in 2006 – a list that does not include New Zealand. Further study will need to be conducted on New Zealand data in order to ensure that the risk-free percentiles in New Zealand are in line with Loderer's estimates.

3.3.3 Step (iii): Distribution of future net cash flows

53. Two key assumptions of Loderer's methodology are that project managers possess sufficient information to identify the distributions of future net cash flows from the

project, and that the managers are able to ignore idiosyncratic sources of variation in providing their estimates.

54. Loderer argues that the second assumption is unlikely to be problematic, since managers with sufficient experience should be able to focus on systematic events in their assessments, and that idiosyncratic events have certain characteristics that allow them to be distinguished from systematic events. However, Loderer acknowledges that neither argument conclusively proves that managers can indeed ignore idiosyncratic errors, and further notes that the estimated conditional mean NCFs from Black's Rule will be biased downwards if these idiosyncratic errors are not ignored.[8]

55. With regard to the issue concerning the distribution of future net cash flows, Loderer acknowledges that "[m]ost managers do not know the distribution of future NCFs in much detail". However, if it is further assumed that the NCFs are normally distributed, then knowing only two points on the distribution would be sufficient. This is because the normal distribution is defined by only two parameters – the mean and the standard deviation. Therefore, the full distribution can be derived from only two observations, such as the mean estimate and the pessimistic estimate at a particular probability.[9]

56. In order to investigate the feasibility of obtaining the information in this step, Loderer surveyed alumni of the Rochester-Bern Executive MBA, asking them to identify whether they could quantify any of the following six properties of the cash flow distributions for recent projects:

i. Average cash flow;

ii. Standard deviation of cash flow;

iii. Dollar amount and rough probability of break-even cash flow;

iv. Dollar amount and rough probability of pessimistic cash flow;

v. Dollar amount and rough probability of optimistic cash flow; and/or

vi. Rough probability of observing zero cash flow.

57. The survey showed that 63 of 107 (54%) respondents were able to provide estimates of at least two of the six properties shown above. This implies that, if it is assumed that NCFs are normally distributed, then their distributions could be derived for the projects managed by 55% of the respondents.

8 Loderer, Long and Roth, Black's Simple Discounting Rule, *Bradley Policy Research Center: Financial Research and Policy*, Working Paper No. FR 08-25, August 2008, pg 19.

9 This is true for any distribution that is defined by two parameters.

58. However, Loderer's survey was specifically framed to ask respondents whether they were able to quantify any of the six characteristics of project cash flow. The survey did not ask for actual quantities, and no subsequent study was carried out to determine how accurate the managers' estimates were. As such, in our view, the use of manager estimates of project cash flow distributions remains a theoretical exercise with unproven practical value.

59. In any event, notwithstanding issues of practicality, the use of manager estimates of project cash flow distributions may not be appropriate for regulatory determinations. This is because regulatory determinations correctly place a higher priority on methodological transparency compared to internal decision making within firms. By nature, the choice of cash flow estimates by managers will involve a high degree of subjective judgement, and would therefore be fairly opaque. We therefore consider that Loderer's implementation of Black's Rule is less suited for regulatory determinations as compared to being used for internal decision making by companies.

60. We also note that Loderer has not attempted to test whether project cash flows are normally distributed, although the Shapiro-Wilk test was used to test for normality in excess returns of the benchmark security. This is understandable because data on individual projects is usually confidential and will thus be difficult to obtain.

61. In our view, however, NCFs for a regulated business are neither symmetric nor normally distributed.[10] For example, large reductions in revenue could occur as a result of infrastructure being damaged by natural disasters, while observing equally large increases in revenue is virtually impossible. This asymmetry suggests that the normal distribution may not be an appropriate assumption for this context.[11]

10 See CEG, Review of the use of the 75th WACC percentile, A report for Orion, May 2014.

11 It might be possible to utilise other skewed distributions with two parameters, such as the Gumbel distribution, but this was not explored by Loderer, and has not been tested in the context of regulatory decisions. Distributions with three or more parameters could be considered, but these would generally require data that is precisely measured, which might not be possible in this case since the cash flow estimates are obtained from subjective managerial estimates instead of directly observable measurements.

4 Ireland, Wallace & Associates' (2015) implementation of Black's Rule in a regulatory context

62. MEUG's submissions include a paper by Ireland, Wallace & Associates Limited (2015),[12] which provides a simplistic application of Black's Rule to Transpower's price-quality path determination.

63. HoustonKemp (2015), on behalf of Powerco, criticised IWA (2015) on the basis that it contained a critical error that invalidated its conclusions. In addition, HoustonKemp (2015) also questioned whether the approach set out in IWA (2015) actually resolved any of the informational difficulties associated with the use of the CAPM.

4.1 Ireland, Wallace & Associates Limited (2015)

64. The IWA paper applies the Loderer *et al* (2008) formulation of Black's Rule to the Transpower decision, which they intended to be used a cross-check against the IM cost of capital estimate.

65. As stated in paragraph 1.2 of the paper, IWA merely sought to "provide the basis for a potential framework and not to form conclusions from the Transpower working example". As such, IWA's example is based on arbitrary modifications, as opposed to using actual data.

66. To that end, IWA makes the following modifications to Loderer's (2008) parameters:[13]

- Initial investment is changed to zero;
- Normal cash flows estimated using Transpower's capital charges as stated in the Commission's decision [332.5, 339.1, 342.8, 345.9, 346.6];
- Pessimistic cash flows "arbitrarily assumed" to be $100 million less than the median cash flows and assumed to reflect the 10th percentile of cash flows; and

12 Ireland, Wallace & Associates Limited, Input Methodology Review: "Black's Simple Discount Rule" a cross check on the IM Cost of Capital for Major Electricity Users' Group, August 2015. Henceforth referred to as "IWA".

13 IWA, Input Methodology Review: "Black's Simple Discount Rule" a cross check on the IM Cost of Capital for Major Electricity Users' Group, August 2015, pg 13.

- Current risk-free rate assumed to be a constant 4.09%, which is reduced to 2.94% after taking the 28% tax rate into account.

67. The market data are unchanged from Table 1. The manager estimates are updated as shown in Table 4.

Table 4: Calculation of conditional mean cashflows (millions)

Year	Pessimist cash flow	Pess. Prob	Normal cash flow	Normal Prob	Est. Stdev	R_f %ile (from Table1)	Est. mean	Current TA R_f
1	232.5	10%	332.5	50%	78.03	34.39%	301.15	2.94%
2	239.1	10%	339.1	50%	78.03	28.83%	295.54	2.94%
3	242.8	10%	342.8	50%	78.03	24.99%	290.14	2.94%
4	245.9	10%	345.9	50%	78.03	22.06%	285.80	2.94%
5	246.6	10%	346.6	50%	78.03	19.78%	280.30	2.94%
NPV							**1,333**	

Source: IWA (2015) Appendix D Tables 3 to 5

68. Discounting the estimated conditional mean in the second-to-last right hand column of Table 4 using the current tax-adjusted continuous risk-free rate results in an NPV estimate of $1.333 billion.

69. Finally, IWA (2015) compared the sum of the estimated conditional mean NCFs from their implementation of Black's Rule (second-to-last column of Table 4) against those derived by the Commission's Maximum Allowed Revenue (MAR) approach.

70. It was found that the Commission's estimated MAR materially exceeded the estimates obtained from Black's Rule:[14]

> *While the NCFs are not strictly comparable, based on the stated set of assumptions the MAR derived NCFs materially exceed Black's Rule certainty equivalent NCFs over the term of the regulatory period. A detailed reconciliation of the two approaches has not been undertaken.*

71. As shown in IWA (2015) Appendix D Table 6, the sum of the Commission's MAR over five years was $1.706 billion, while the certainty equivalent NCFs from Black's Rule only summed to $1.453 billion.

72. It appears that the conclusion the reader is intended to draw from this is that, because Black's Rule resulted in a lower certainty equivalent valuation than the MAR, this would imply (if the IWA assumptions were all correct) that the

14 IWA, Input Methodology Review: "Black's Simple Discount Rule" a cross check on the IM Cost of Capital for Major Electricity Users' Group, August 2015, paragraph 5.4.

Commission's MAR is overly generous. However, this is exactly the wrong interpretation of this result. A low certainty equivalent value implies that the correct discount rate is high (i.e., that there is a high risk premium associated with the cash flow). The lower the certainty equivalent value as a proportion of the risky cash flow implies the cash-flow is more risky, not less.

4.2 HoustonKemp's (2015) criticism of IWA

73. HoustonKemp (2015) conducted a review of IWA (2015) and identified an error in the latter's analysis, but did not conduct a review of the assumptions that IWA had used in its "certainty equivalent" transformation.

74. HoustonKemp (2015) provided two main criticisms of IWA (2015):

- That Black's simple discount rule is not actually simple to implement because of information requirements; and
- That IWA should have discounted the estimated conditional mean in Table 4 by the Commissioner's WACC estimate of 7.19% instead of the tax-adjusted risk-free rate of 2.94%.

75. HoustonKemp correctly point out that the *discounted* streams of expected and conditional cash flows should have the same NPV, and not the *undiscounted* streams.

76. In making its conclusion that the MAR NCFs materially exceeded the Black's Rule certainty equivalent NCFs, however, IWA (2015) had compared the undiscounted cash flow streams. This is a critical error because the MAR NCFs would naturally exceed the certainty equivalent NCFs, since the former is calculated with respect to the project's risk, while the latter is analogous to a risk-free cash flow. The sum of the former must exceed that of the latter (unless the MAR has negative risk), and the corresponding difference would reflect the risk premium on the project cash flows.[15]

77. As such, the normal cash flows in Table 4 should have been discounted by the WACC estimate and then compared to the conditional means discounted by the risk-free rate. The discounted cash flow streams are shown in Table 5.[16]

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15 HoustonKemp, Comment on Select Submissions to the Commission's Input Methodologies Review: A report for Powerco, September 2015, pg 4.

16 The MAR cash flows are discounted at a rate of 7.19%, while the certainty equivalent cash flows are discounted at a rate of 2.94%. The discounted cash flows shown in the table differ slightly from Table 1 of HoustonKemp (2015) because we discount using continuous compounding, while HoustonKemp (2015) use annual compounded discounting. Our use of continuous compounding is in line with the approaches used by Loderer *et al* (2008) and IWA.

Table 5: Comparison of discounted and undiscounted cashflows

Year	Undiscounted MAR	Discounted MAR	Undiscounted certainty equivalent	Discounted certainty equivalent
2016	332.5	309.43	301.15	292.41
2017	339.1	293.68	295.54	278.64
2018	342.8	276.29	290.14	265.61
2019	345.9	259.45	285.80	254.04
2020	346.6	241.94	280.30	241.92
NPV	1,380.79		1,333.62	

Source: HoustonKemp (2015) Table 1; CEG analysis

78. With this correction, the difference between the sums of the discounted MAR cash flows and discounted certainty equivalent cash flows is reduced from the original estimate of $254 million to only $58 million. HoustonKemp also point out that increasing the regulatory WACC to 8% further reduces the difference to $29.3 million. This supports the point that we make at paragraph 72 above. Specifically, the fact that the present value of the MAR NCF discounted at the regulatory WACC is higher than the present value of the certainty equivalent estimates suggests that the correct discount rate is higher than the regulatory WACC (not lower). [17]

79. HoustonKemp (2015) also argue that IWA's underlying assumptions are "unlikely to be sufficient to base any credible assessment of whether the allowed rate of return is above or below that suggested by a benchmark security", although they did not carry out a detailed review of IWA's certainty equivalents.

80. Finally, HoustonKemp conclude that Black's Rule is "not well-suited to providing a cross-check on the regulated rate of return in the current context" due to its:[18]

- Information intensity;
- Controversial evaluation of certainty equivalents;
- Untested nature; and
- Difficulty in interpreting a difference between two NPVs.

[17] That is, if we believe that the discounted value of the certainty equivalent estimates is correct then the correct discount rate for the MAR NCF is the discount rate that makes the present value of the MAR NCF equal to the present value of the certainty equivalent estimates.

[18] HoustonKemp, Comment on Select Submissions to the Commission's Input Methodologies Review: A report for Powerco, September 2015, pg 5.

4.3 Further issues with IWA (2015)

81. As discussed in Section 4.1, IWA's paper was intended to outline a potential framework as to how Loderer's methodology could be applied, and was not meant to form conclusions regarding Transpower's MAR revenues. Nevertheless, this section points out some of the further issues with IWA's paper that would affect their final results, namely:

- Step (i):
  i. IWA did not check whether the S&P 500 benchmark series tracks with Transpower's incoming cash flow;
- Step (ii):
  i. In calculating the probability of non-positive benchmark returns, IWA used the same percentiles as Loderer's, which is based on 30-day US Treasury bills, instead of using New Zealand data; and
- Step (iii):
  i. IWA arbitrarily sets the pessimistic prediction of incoming cash flow at $100 million less than the median, and arbitrarily assumed that it corresponds to the 10th percentile of the cash flow distribution;
  ii. The assumption of normality may not be appropriate in the context of regulation;
- Step (iv):
  i. IWA discounts the estimated conditional mean cash flows (Step (iv)) using the Commission's 5-year risk-free estimate, which leads to inconsistent results due to its implicit use of the 30-day US Treasury bills in Step (ii).

82. These issues are discussed in greater detail in Sections 4.3.1 to 4.3.4.

4.3.1 Step (i): Use of S&P 500 as the benchmark series for Transpower's incoming cash flow

83. As stated in Section 3, the first step of Loderer's approach requires finding a benchmark security or index that closely correlates with the project's NCFs, and has an independent error term with zero mean. Loderer tested the choice of S&P 500 as a benchmark for the operational cash flows of firms in the Compustat database.

84. The above approach is appropriate for Loderer's study, which was US-centric. However, the approach would not be appropriate for the Commission's assessment, which would require the benchmark series to be tested against the cash flows of firms in New Zealand.

85. In addition, Loderer's study was not focused on a specific industry, and was instead conducted for all non-financial firms on Compustat. Even then, Loderer's empirical assessment suggests that only around a quarter of the firms have an associated regression R^2 of 0.4, which suggests that the S&P 500 index would not be a good fit for the remaining three quarters of the firms in the sample. As stated by Loderer:[19]

> *The set-up of our investigation probably makes our quest for large explanatory power difficult, since we are considering a large benchmark aggregate and, especially, company-wide NCFs. Aggregate NCFs could represent the consolidation of widely different projects with diverse risk characteristics. Conceivably, breaking down the benchmark returns to industry (possibly firm-specific) returns, and focusing on project (as opposed to company-wide) NCFs, could yield even tighter fits.*

86. IWA's use of the S&P 500 index as the benchmark series for Transpower's incoming cash flow is therefore highly problematic. In order for Loderer's implementation of Black's Rule to be carried out, it would be necessary to first ascertain whether the S&P 500 index is closely correlated with the NCFs of regulated firms in New Zealand. If this is not the case, then another benchmark with higher correlations would be required.

4.3.2 Step (ii): Use of Treasury bills for calculating the probability of non-positive benchmark returns

87. In Step (ii) of its example, IWA used the same set of percentiles set out in Loderer's example, which was based on a comparison of US Treasury bills against the S&P 500 benchmark index.

88. This is unlikely to be appropriate in the context of regulated firms in New Zealand, which would have different characteristics compared to firms in the US. Although Loderer stated that "[i]f capital markets were reasonably integrated, their risk-free percentiles ought to be similar",[20] the results shown in Table VII of their paper are based on a study of the 10 largest stock markets in 2006, which does not include New Zealand.

89. Another issue is that the risk-free percentiles calculated in Step (ii) will need to be checked for stationarity across time, in order to ensure that the percentiles derived from the full historical data series are appropriate for use in the current time period. Loderer carried out Wilcoxon rank-sum tests that compares the distribution of percentiles from each decade against the full sample, as well as Shapiro-Wilk tests

19 Loderer, Long and Roth, Black's Simple Discounting Rule, *Bradley Policy Research Center: Financial Research and Policy*, Working Paper No. FR 08-25, August 2008, pg 17.

20 Loderer, Long and Roth, Black's Simple Discounting Rule, *Bradley Policy Research Center: Financial Research and Policy*, Working Paper No. FR 08-25, August 2008, pg 27.

for normality, but these were only done for the US sample and not for the international data.

90. Therefore, in order for Step (ii) to be carried out for the present context, the risk-free rate would need to be estimated using New Zealand data instead of the US Treasury bills, and statistical tests would need to be applied in order to ensure that the risk-free percentile is indeed stationary across time.

4.3.3 Step (iii): Pessimistic estimates of future cash flows and the normality assumption

91. IWA "arbitrarily assumed" that the pessimistic estimates of future cash flows were $100 million less than the cash flows in the Transpower decision. These pessimistic cash flows were also assumed to correspond to the 10th percentile of the cash flow distribution, while the cash flow from the Transpower decision was assumed to be the median. Clearly, these arbitrary numbers will need to be replaced with empirical estimates before they can be applied in regulatory decisions.

92. Bearing in mind that the primary purpose of IWA's report appears to be a demonstration of the feasibility of Black's Rule – as opposed to an attempt at drawing conclusive inferences about the Commission's decision – we nevertheless question whether it would be feasible or appropriate to estimate the distribution of future cash flows in this context using the methodology suggested by Loderer. This was discussed in Section 3.3.3, which highlighted issues such as whether estimates from managers would be appropriate for regulatory decisions, as well as the questionable assumption that the project cash flows are normally distributed.

4.3.4 Step (iv): Discounting of conditional mean cash flows

93. As discussed in Section 4.2, HoustonKemp criticised IWA's findings on the basis that the latter had compared the undiscounted cash flow streams, when the correct approach should have been to compare the discounted cash flows, with the actual cash flows being discounted by the Commission's WACC estimate, and the certainty equivalent cash flows being discounted by the risk-free rate. We agree with HoustonKemp that the comparison should be carried out on the discounted cash flows.

94. In addition, IWA's choice of interest rates is inconsistent across Steps (ii) and (iv). When calculating the risk-free percentiles in Step (ii), IWA used the same percentiles that Loderer had obtained from comparing US Treasury rates against the S&P 500 benchmark index. In Step (iv), however, IWA discounted the certainty equivalent cash flows using the Commission's estimated risk-free rate.

95. Such an inconsistency should be avoided because it would mean that the risk-free percentiles derived in Step (ii) may not be an appropriate proxy of the certainty-

equivalent percentile to be used in Step (iii). Furthermore, this inconsistency would invalidate the statistical tests carried out in Step (ii). For example, Loderer carried out Wilcoxon rank-sum tests to check that the risk-free percentiles were stationary, as well as Shapiro-Wilk tests for normality. The findings of these tests cannot be applied directly to a different series of risk-free rates.

5 Conclusion

96. We have reviewed the reports by Loderer *et al* (2008), IWA (2015), and HoustonKemp (2015). We concur with HoustonKemp's correction of IWA's methodology, and have also carried out further evaluation of the analysis carried out by Loderer and IWA.

97. In particular, Loderer's implementation of Black's Rule suffers from the following drawbacks if it is to be applied to New Zealand regulated businesses:

- The S&P 500 index as the chosen benchmark security does not have a high correlation with three quarter of the firms in the Compustat sample;
- The international risk-free percentiles were estimated for a list of countries that did not include New Zealand;
- The future net cash flows are assumed to be normally distributed, which does not accord with the asymmetric costs of regulated businesses;
- The future net cash flows are estimated based on managerial estimates, and are assumed to be free of idiosyncratic sources of variation;
- No attempt was made to establish the accuracy of managerial estimates of future net cash flows; and
- Managerial estimates tend to be opaque and subjective, which does not accord with the methodological transparency that is emphasised in regulatory decisions.

98. IWA's application of Loderer's method for the Transpower decision is also subjected to the following additional shortcomings:

- The S&P 500 index was selected as the benchmark security without testing for correlation against Transpower's cash flows – most likely because no data was available;
- US Treasury bills were used for calculating the risk-free percentile instead of using New Zealand data;
- Future NCFs were assumed to be normally distributed and were derived from arbitrary estimates of pessimistic cash flows; and
- Inconsistent use of risk-free rates when calculating risk-free percentiles and when discounting the certainty equivalent cash flows.

99. Two further observations should be noted about IWA's conclusions. First, IWA's conclusion that the MAR NCFs materially exceeded the Black's Rule certainty equivalent NCFs is incorrectly based on a comparison of the undiscounted cash flow streams. Correctly discounting the cash flow streams results in a narrower gap in NCFs.

100. Second, IWA's interpretation of the low NCF obtained from Black's Rule implies that the correct discount rate is higher than allowed by the Commission (i.e., that there is a high risk premium associated with the cash flow). This is because a lower the certainty equivalent value as a proportion of the risky cash flow implies the cash-flow is more risky, not less.