Input Methodology Review

"Black's Simple Discount Rule"

a cross check on the IM Cost of Capital

for

Major Electricity Users' Group

Ireland, Wallace & Associates Limited

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Author: Garth Ireland
Ireland, Wallace & Associates Limited
PO Box 25359, Featherston Street,
Wellington 6146, NEW ZEALAND

(04) 4733403 or 0212 494 359
garth.ireland@xtra.co.nz

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Table of Contents

1 Instruction

1.1 The Major Electricity Users' Group (MEUG) has asked Ireland, Wallace & Associates Limited (IWA) to:

(a) demonstrate how the "Black's Simple Discount Rule" (Black's Rule) can be used as a potential cross-check for price-quality control paths based on cost of capital, and

(b) prepare two related spreadsheet outputs: the replication of the example used by Loderer et al.[1] and a version adapted to illustrate a framework referencing to the recent Transpower individual price-quality path determination.[2]

1.2 MEUG has also required IWA to provide the basis for a potential framework and not to form conclusions from the Transpower working example.

2 What is the Black's Rule?

2.1 The objective of Black's Rule is to provide a project valuation in a simpler way than by the traditional Discount Cash Flow approach using the Capital Asset Pricing Model (CAPM) in the cost of capital calculation.[3] Black's methodology has one discount rate, the observed risk free rate. In contrast the CAPM/WACC formulation applied by the Commission requires various variables be either observed or estimated.

2.2 The cash flows required for Black's Rule are termed "conditional" expected cash flows which are discounted at risk-free rates as if they were certain. These cash flows are what economists call "certainty equivalents." CAPM in contrast discounts the expected (or unconditional) cash flows.

2.3 The virtue of Black's Rule is that it shifts the focus away from discount factors to estimating cash flows.

2.4 The prime context for demonstrating the potential implementation is the working paper: "Black's Simple Discounting Rule"[4] (Loderer). It comprehensively links

[1] Loderer, Claudio F. and Long, John B. and Roth, Lukas, **Black's Simple Discounting Rule,** 2008 (updated to January 21, 2013). Simon School Working Paper No. FR 08-25, and
Loderer, Claudio F. and Long, John B. and Roth, Lukas, **Implementing Fischer Black's Simple Discounting Rule,** Journal of Applied Corporate Finance, Vol. 22, Issue 2, pp. 60-68, Spring 2010.
See: http://www.comcom.govt.nz/dmsdocument/13453

[2] Commerce Commission: "Companion paper to final determination of Transpower's individual price-quality for 2015-2020", 28 November 2014.

[3] The valuation objective of the Black method is reinterpreted in the context of price-path control regulation to provide a basis for comparing implicit risk of the two approaches.

[4] See footnote 1.

Fischer Black's[5] contribution, and a review by Stewart Myers,[6] empirical research and statistical testing leading to a workable tool. The paper speaks for itself.

3 Implementing Black's Rule

3.1 The Loderer working paper provides a valuation example.[7] The four steps are:

1. Find a benchmark security with returns that closely correlates with the project's NCFs;

2. Estimate the probability of negative excess benchmark returns (what risk-free percentile ensures the benchmark return);

3. Use management information to assess the NCFs that define the same percentiles in the cash flow distribution (the "conditional" expected cash flows that Black's Rule calls for);[8] and

4. Discount the conditional cash flows at the matching risk-free rates to determine a valuation ("NPV").

3.2 The Loderer example in the Loderer paper is presented step by step in **Appendix A**. Extracts from the example spreadsheet are preceded by brief introductions. The key excel formulas are highlighted.

4 Transpower example: assumptions and data

4.1 The proposed extension to the New Zealand regulated utilities is novel. The most difficult part of implementing Black's Rule is the estimation of "conditional" Net Cash Flows (NCFs) it calls for. The reality is that the Commission in determining cash flows for price control is in a well-informed position to describe the risk in cash flows line by line.

4.2 In implementing Black's Rule as a cross check on the Maximum Allowed Revenue (MAR) determined by the Commission, selected data has been drawn from the Transpower's individual price-quality path for 2015-2020 final determination but just sufficient to demonstrate how Black's Rule might apply to Transpower.[9] [10]

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[5] Fischer Black, "**A Simple Discounting Rule**", Financial Management, Vol.17, No. 2 (Summer,1988).

[6] Stewart Myers, **"Legacy of Fischer Black"**, p38-39.
http://www.jstor.org/discover/10.2307/3665592?sid=21105551232433&uid=2&uid=4&uid=3738776

[7] Appendix A: "Comprehensive Example", p39-40.

[8] See Loderer (2008): Figure 1, "Benchmark returns and associated conditional mean NCFs", p38 and related to p9-10.

[9] See footnote 2.

[10] The application of "cost of capital", whether vanilla or post-tax, was not checked. It is not important for this demonstration.

4.3 The building blocks leading to the MAR are summarised in **Appendix B**. About 63% of the MAR is depreciation and capital charges. A breakdown of the forecast 2015 line "Operating Expenditure" shows the relative importance of each expenditure line which make up about 31% of the MAR.

4.4 For purpose of demonstrating the application of Black's Rule the NCFs have been defined as Net Operating Profit after Tax (NOPAT). The difference between MAR and Total Cost is assumed to represent the Capital Charge. The Capital Charge is assumed to be equivalent to NOPAT, i.e. NOPAT less the Capital Charge balances return and cost.

4.5 For consistency the benchmark security and returns are assumed to closely correlate with NOPAT.[11] This is a pre-qualification for Black's Rule to apply.

4.6 For the working example the scenarios for "normal" and "pessimistic" NCFs are referenced to the Transpower 2015-2020 price-quality determination.[12] The probabilities of 50% and 10% were assigned to normal and pessimistic NCFs respectively. They represent the chances of lower NCFs.[13] The probabilities assumed by Loderer are retained to illustrate the framework for price control application.

4.7 The "pessimistic" average NCF is arbitrarily assumed to be $100 million less than the average "normal" NCF. The following table summarises the scenarios:

Working Assumptions based on Transpower RCP2 generalised data:							
"Normal Average Net Cash Flows"			**2016**	**2017**	**2018**	**2019**	**2020**
		$m					
MAR			882	919	952	949	957
"Expenditure"			(549)	(580)	(609)	(604)	(610)
Expected NCF	defined as NOPAT		**333**	**339**	**343**	**346**	**347**
Probability of lower NCF	Input:	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**
"Average Pessimistic Net Cash Flows"							
MAR			882	919	952	949	957
"Expenditure"			(549)	(580)	(609)	(604)	(610)
"Sum of NCF adjustments"			(100)	(100)	(100)	(100)	(100)
Expected NCF			**233**	**239**	**243**	**246**	**247**
Probability of lower NCF	Input:	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**

[11] Loderer, "Consistent with CAPM assumptions, the security in question could be the market portfolio, but it could also be an industry portfolio or some other security – conceivably, even the firm's own stock", p3.

[12] Appendix B, 5 table.

[13] See Appendix A and "Step 3" for a fuller description.

4.8 A framework for estimating the pessimistic scenario on a line-item component basis with suggested categories are set out in **Appendix C.** The "Sum of line-items components after tax" of negative $100m is a place holder for categories each subject to Black's Rule.

4.9 The downside risk mitigation mechanisms available to Transpower to be considered include the revenue cap, the economic value account carry forward provision, reopeners for catastrophic and other events, pass-through and other recoverable cost provisions, etc.

5 Transpower example: financial framework and model

5.1 For the purposes of demonstrating application of Black's Rule to the Commission's 2015-2020 price-quality path (or revenue cap) setting, the NCFs and related subjective "probabilities of lower NCF" for the normal and pessimistic states respectively are set out in paragraph 4.7 above.

5.2 Following the Loderer valuation example in **Appendix A** steps 1 to 4 were followed. The changes included the assumption the NCFs were defined as NOPAT and for consistency a tax rate was applied to the risk-free rate in the NPV calculation. The current risk-free rate was simply the 5 year rate of 4.09% set by the Commission for the revenue cap applied annually. As we are addressing a stream of NCFs initial investment is zero.

5.3 A comparison of the MAR and the related "unconditional" NCFs (NOPAT in this case) incorporating CAPM/WACC at 67th percentile can be compared to "conditional" NCFs estimated using Black's Rule incorporating an implied risk free rate. The NCFs are summarised in **Appendix D** section 6**.**

5.4 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.

6 Summary

6.1 Black's Rule provides another lens on the return required for risk in the context of New Zealand's price control regulation.

6.2 Black's Rule focuses on cash flows and not discount rates. The certainty equivalent approach to categories and line items allows for a refined balancing of risk for reward assessments.

6.3 The spreadsheet outputs provide frameworks and models for developing and implementing Black's Rule as a potential cross-check of price-paths based on CAPM/WACC rates.

Appendix A: Loderer valuation example

The four steps in the Loderer Valuation example:[14]

Step 1 *Find a benchmark security and returns that correlates with the Net Cash Flows (NCFs) of the project.*

The CRSP Value Weighted Index[15] is chosen as a proxy for the benchmark security. Assuming returns are normally distributed and based on the index for 1942 to 2005 the average return is 11.39% and standard deviation 15.58%. The risk free rates are the Treasury Yields that match the duration of the project NCFs.

	B	C	D	E	F	G	H	I
9								
10	**Benchmark Security**							Title
11				CRSP Value Weighted Index [Normally distributed				Input
12				continuously compounded annual stock return on Index]				Calculation
13	**1942-2005**		**Treasury Yields**					Result
14	1-year		5.13%					
15	2-year		5.24%					
16	3-year		5.32%					
17	4-year		5.39%					
18	5-year		5.47%					
19								
20	1942-2005	Average Market Return		11.39%				
21		Standard Deviation			15.58%			
22								

Step 2 *Estimate the probability of negative excess benchmark returns (what risk-free percentile ensures the benchmark return).*

The probability that the benchmark security will return less than the risk-free rate for the time horizons of one to five years is estimated. Studies by Loderer find that risk-free percentiles appear to be stationary over time and similar across ten countries including Australia.[16]

	B	C	D	E	F	G	H	I
23	**Benchmark Security Risk-free Percentiles**							
24	B	C	D	E	F	G	H	I
25		**Cumulative**	**Standard**	**Cumulative**	**Probability that Rm equals**			
26		**Average Rm**	**Deviation Rm**	**Risk-free rate**	or **is less than the risk-free rate**			
27	**Year of NCF**					*p*		
28	1	11.39%	15.58%	5.13%		34.39%		
29	2	22.78%	22.03%	10.48%		28.83%	=NORM.DIST(E28,C28,D28,TRUE)	
30	3	34.17%	26.99%	15.96%		24.99%		
31	4	45.56%	31.16%	21.56%		22.06%		
32	5	56.95%	34.84%	27.35%		19.78%		

Step 3 *Use management information to assess the NCFs that define the same percentiles in the cash flow distribution (the conditional expected cash flows that Black Rule calls for).*

Given an assumption of normality two points in the distribution the full distribution can be defined. “Scenario 2” is the expected mean unconditional (or normal) NCF and hence there is a 50% probability that NCFs will fall below the value. “Scenario 1” is the pessimistic mean value with a 10% probability that the value will be less than this mean.

[14] See footnote 6.

[15] CRSP stands for “The Centre for Research in Security Prices”.

[16] See Loderer Table VII, p37.

	B	C	D	E	F	G	H	I
33								
34	**Firm Cash Flows Distribution Percentiles**							
35								
36		**Scenario 1:**		**Scenario 2:**				
37		*Pessimistic*	**Probability**	*Normal*	**Probability**			
38	**Year of NCF**	**Ave NCF**	**lower NCF**	**Ave NCF**	**lower NCF**			
39	1	200.00	10%	500.00	50%			
40	2	300.00	10%	700.00	50%			
41	3	300.00	10%	700.00	50%			
42	4	200.00	10%	500.00	50%			
43	5	100.00	10%	200.00	50%			
44								

Given two data points the standard deviation of the NCFs are estimated and hence their percentiles. The risk-free percentile of the benchmark security is matched, using tables for standard normal variables, to the same percentile of the NCFs. The result is the conditional expected NCF.

	B	C	D	E	F	G	H	I
45	**Conditional Expected NCFs**				=STANDARDIZE(E28,C28,D28			
46		C	D	E	F	G	H	I
47		**Expected Mean**	**Standard Deviation**	*Standardise*	**Risk-free**	*Standardise*	**Conditional**	
48		**Future NCF**	**of Future NCF**		**Percentile**		**Expected NCF**	
49	**Year of NCF**			*check z*	*p*	*z*		
50	1	500.00	234.05	-1.282	34.39%	-0.402	405.96	
51	2	700.00	312.06	-1.282	28.83%	-0.558	525.79	
52	3	700.00	312.06	-1.282	24.99%	-0.675	489.42	
53	4	500.00	234.05	-1.282	22.06%	-0.770	319.73	
54	5	200.00	78.02	-1.282	19.78%	-0.850	133.71	
55			z table		=STANDARDIZE(C39,E39,D50)		=(G50*D50)+C50	
56		=(C39-E39)/D56	-1.282					

Step 4 *Discount the conditional NCFs at the matching risk-free rates.*

The conditional expected NCFs are discounted at the matching duration current risk-free rate and the valuation derived.

	B	C	D	E	F	G	H	I
58								
59		**Investment**	**Conditional**	**Current**	**Tax rate**	**Present Value**		
60			**Expected NCF**	**Risk-free**		**Expected NCF**		
61	**Year of NCF**							
62	0	(1,200.00)				(1,200.00)		
63	1		405.96	5.25%	0%	385.20	=D63*EXP(-E63*B63)	
64	2		525.79	5.30%	0%	472.91		
65	3		489.42	5.45%	0%	415.60		
66	4		319.73	5.50%	0%	256.59		
67	5		133.71	5.60%	0%	101.06		
68	**NPV**					**431.36**		

Appendix B: Transpower example assumptions and data

1. Transpower's MAR for the period 2015 to 2020 for has been determined by the Commission. The composition of the MAR building blocks provides line by line cash flows.

2. Extensive information is available to the Commission for implementing Black's Rule. The Commission processes involve: public consultations supported by economic, financial and engineering expert reports and periodic information disclosures. Transpower, for example, forecasts revenue and costs for at least 5 years and asset management plans for 10 years, prepares Statement of Corporate Intents, releases quarterly and annual reports, is required to publish an Annual Regulatory Report, reports to the NZX, etc.

3. The Commission and the Transpower are well informed of potential variability in all line by line items which underpins the price/revenue settings. They can create realistic scenarios required by Black's Rule supported by meaningful distributions around point estimates.

4. The Commission and Transpower are "active learners" as a result of first, periodic setting price paths/revenue caps and second, from subsequent performance monitoring.

5. The summarised MAR composition and Expenditure breakdowns for Transpower are:

Transpower Working Example Base Data

1 **Transpower Forecast MAR Building Block Breakdown: RPC2**

67th percentile WACC	**2016**	**2017**	**2018**	**2019**	**2020**	*2015-2020*	Composition
$m							Average
Forecast MAR	881.6	918.6	951.8	949.4	956.8	4,658.2	100%
Depreciation	(234.0)	(240.0)	(253.1)	(245.8)	(246.9)	(1,219.8)	26.2%
Operating Expenditure	(277.7)	(285.7)	(293.5)	(295.1)	(297.5)	(1,449.5)	31.1%
Tax	(39.0)	(39.6)	(48.2)	(48.3)	(51.5)	(226.6)	4.9%
TCSD	(2.6)	(2.6)	(2.6)	(2.7)	(2.7)	(13.2)	0.3%
EV adjustment/other	4.2	(11.6)	(11.6)	(11.6)	(11.6)	(42.2)	0.9%
	(549.1)	(579.5)	(609.0)	(603.5)	(610.2)	(2,951.3)	63.4%
Capital Charge	332.5	339.1	342.8	345.9	346.6	1,706.9	36.6%

NOPAT is assumed to equal the Capital Charge

Source: Table 2.3, "Companion paper to final determination of Transpower's IPP for 2015-2020", 28 Nov 2014

2 **Transpower Expenditure breakdown forecast 2014-15**

	$m	
Grid maintenance	(100.1)	37.9%
IST maintenance	(30.2)	11.4%
IST leases	(12.7)	4.8%
Investigations	(8.7)	3.3%
Ancillary services	(3.0)	1.1%
Departmental	(95.8)	36.3%
Insurance	(13.3)	5.0%
Total operating expenditure	(263.8)	100%

Source: Table 27, "Annual Regulatory Report", 2014

Appendix C: Transpower line-item framework example

A	**Framework for estimating the pessimistic scenario:**							
	"Line-item Components":		**2016**	**2017**	**2018**	**2019**	**2020**	
	Revenue examples	$m						
1	**"MAR"**		882	919	952	949	957	
	adjusted to	-1%	873	909	942	940	947	
	uncertain NCF		**(9)**	**(9)**	**(10)**	**(9)**	**(10)**	
		basis:	Revenue cap gives certainty of recovery of 5 years revenue.					
	Expenditure/Capital examples		Debtor timing delay etc. say, 1% of MAR.					
2	**"Capital Charges"**		(333)	(339)	(343)	(346)	(347)	
	adjusted to		(333)	(339)	(343)	(346)	(347)	
	uncertain NCF	?	**-**	**-**	**-**	**-**	**-**	
		basis:	Unexpected rise in riskfree rate affecting 67th percentile WACC.					
			Is the RF hedge cost included in Transpower's MAR?					
3	**"Catastrophic event/change/error"**							
	Operating Expenditure		(278)	(286)	(294)	(295)	(298)	
	adjusted		(305)	(314)	(323)	(325)	(327)	
	uncertain NCF	1%	**9**	**29**	**29**	**30**	**30**	
		basis:	(1) IPP Subpart 7 trigger: minimum equal to 1% of forecast MARs					
			net of insurance payable.					
		basis:	(2) If triggered what is uncertain based on Orion CPP precedent?					
4	**"Catastrophic event"**							
	RAB opening		4,307	4,610	4,709	4,784	4,832	
	adjusted		4,307	4,610	4,709	4,784	4,832	
	uncertain NCF	?	**-**	**-**	**-**	**-**	**-**	
		basis:	HVDC link broken/EDB catastrophic event net of insurance.					
			RAB stranding/write-offs					
5	**Major Capex Project over runs recovery**							
	RAB		4,307	4,610	4,709	4,784	4,832	
	adjusted		4,307	4,610	4,709	4,784	4,832	
	uncertain NCF	?	**-**	**-**	**-**	**-**	**-**	
		basis:	North Island Grid Upgrade precedent.					
6	**Finance event**							
	Debt							
	adjusted							
	uncertain NCF	?						
		basis:	Credit rating changed from AA- to lower grade					
			But, protected by BBB+ WACC standard					
7	**IRIS rolling incentive scheme**							
	Opex							
	adjusted							
	uncertain NCF	?						
		basis:	Contract risk reward balance?					
	Regulation examples							
8	**EA pricing risk**							
	MAR							
	adjusted							
	uncertain NCF	?						
		basis:	Proposed restructuring of Transmission Pricing adverse effect					
	Sum of line-item components after tax (1 to 8)	say,	**(100)**	**(100)**	**(100)**	**(100)**	**(100)**	
B	**Downside risk mitigation mechanisms/rights/understanding include:**							
	Revenue assurance/cap							
	Economic value account carry forward							
	Reopeners for "catastrophic events", "change events" and "errors"							
	Pass through of costs							

Appendix D: Transpower financial model output

"Black's Rule" Application: Transpower

1 Benchmark Security

			CRSP Value Weighted Index [Normally distributed			Title
			continuously compounded annual stock return on Index]			Input
						Calculation
1942-2005		**Treasury Yields**				Result
1-year		5.13%				
2-year		5.24%				
3-year		5.32%				
4-year		5.39%				
5-year		5.47%				
1942-2005	Average Market Return		11.39%			
	Standard Deviation			15.58%		

2 Benchmark Security Risk-free Percentiles

	Cumulative Average Rm	Standard Deviation Rm	Cumulative Risk-free rate	Probability that Rm equals or is less than the risk-free rate	
Year of NCF					*p*
1	11.39%	15.58%	5.13%		34.39%
2	22.78%	22.03%	10.48%		28.83%
3	34.17%	26.99%	15.96%		24.99%
4	45.56%	31.16%	21.56%		22.06%
5	56.95%	34.84%	27.35%		19.78%

3 Firm Cash Flows Distribution Percentiles

	Scenario 1:		Scenario 2:		
	Pessimistic	Probability	*Normal*	Probability	
Year of NCF	Ave NCF	lower NCF	Ave NCF	lower NCF	
1	**232.50**	10%	**332.50**	50%	
2	**239.10**	10%	**339.10**	50%	
3	**242.80**	10%	**342.80**	50%	
4	**245.90**	10%	**345.90**	50%	
5	**246.60**	10%	**346.60**	50%	

4 Conditional Expected NCFs

	Expected Mean Future NCF	Standard Deviation of Future NCF	*Standardise*	Risk-free Percentile	*Standardise*	Conditional Expected NCF
Year of NCF			*check z*	*p*	*z*	
1	**332.50**	78.02	-1.282	34.39%	-0.402	**301.15**
2	**339.10**	78.02	-1.282	28.83%	-0.558	**295.55**
3	**342.80**	78.02	-1.282	24.99%	-0.675	**290.15**
4	**345.90**	78.02	-1.282	22.06%	-0.770	**285.81**
5	**346.60**	78.02	-1.282	19.78%	-0.850	**280.31**
		z table				
		-1.282				

5 Net Present Value

	Investment	Conditional Expected NCF	Current Risk-free	Tax rate	Risk-free after tax	Present Value Expected NCF
Year of NCF				28%		
0	-					-
1		301.15	4.09%	28%	2.94%	292.41
2		295.55	4.09%	28%	2.94%	278.64
3		290.15	4.09%	28%	2.94%	265.62
4		285.81	4.09%	28%	2.94%	254.05
5		280.31	4.09%	28%	2.94%	241.94
NPV						**1,332.67**

6 Analysis

	Expected Mean Future NCF	Conditional Expected NCF	difference
Year of NCF			
1	332.5	301.2	*-31.3*
2	339.1	295.5	*-43.6*
3	342.8	290.2	*-52.6*
4	345.9	285.8	*-60.1*
5	346.6	280.3	*-66.3*
	1,706.9	1,453.0	*-253.9*

Discount Rate	**CAPM/WACC**
	Risk-free