



Public Sector Discount Rates for Cost Benefit Analysis

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Purpose

The discount rate plays an important role in the cost-benefit analysis of public sector projects. The Treasury's "Cost Benefit Analysis Primer" sets out what discount rate is appropriate in any situation and how it should be used¹. This note explains how the discount rates were arrived at.

Introduction

There is a wide-ranging academic literature on the setting of a public sector discount rate. Broadly speaking there are two approaches plus a couple of variants:

- a One is based on the view that the discount rate should reflect government policy preferences². This is one version of the so-called "**social rate of time preference**". The main exponent is probably Martin Feldstein, but others include O Eckstein and S A Marglin. A more recent exponent is Sir Nicholas Stern's review of the economics of climate change. However, most exponents of this view recognise that the opportunity cost of capital (see below) should be recognised where the alternative is for the funds to be invested in the private sector.
- b The financial economics literature takes the view that the discount rate should reflect the **social opportunity cost of capital**, which in turn depends on the level of non-diversifiable risk in a project. It is in effect the pre-tax rate of return that can be expected from private sector investments that have similar risk characteristics. The main tool used to calculate this discount rate is the capital asset pricing model (CAPM). The main Australasian academic exponents are Bob Officer from Monash University and the University of Melbourne and Martin Lally from Victoria University of Wellington. It has been adopted internationally by the main multilateral organisations and a number of countries including France and Canada (see below). It is the approach that underpinned the existing Treasury discount rate since at least 1971 and is also the logic followed by the capital charge calculation.
- c Another is a hybrid of the "social rate of time preference" and the "social opportunity cost of capital". The discount rate equals the sum of the after-tax Government bond rate (or some other measure of the rate at which individuals save in secure investments) and the expected growth rate in per capita consumption times the negative elasticity of marginal utility with respect to consumption. The main academic exponent is probably A C Lind and the approach has been adopted by the UK Treasury in its Green Book on project appraisals.
- d Finally, some commentators draw attention to the "equity premium puzzle", i.e. the fact that the difference between empirical values of the risk-free interest rate and the return on equity is much larger than predicted by theory, and conclude that the

¹ See <http://www.treasury.govt.nz/publications/guidance/costbenefitanalysis/primer>.

² Feldstein states that it "must reflect public policy and social ethics, as well as judgement about future economic conditions" and "Our own view would be to allow administrative determination of the S.T.P. [social time preference rate] with whatever weight to the welfare of future generations these democratic administrators would allow." Feldstein, Martin, 1964, "The Social Time Preference Discount Rate in Cost Benefit Analysis", *Economic Journal* June, p.362 and 367.

government's opportunity cost of capital is much lower than indicated by the CAPM. This approach appears to be followed by Germany and the U.S., who set their discount rates equal to their pre-tax government borrowing rates.

Some of these views may not be as irreconcilable as they seem. For example, the principal advocates of the social rate of time preference approach acknowledge that the opportunity cost of capital must be taken into account as a shadow price. The practical effect of doing so is arguably not that different from taking the social opportunity cost of capital approach, at least where cash flow profiles are similar.

The opportunity cost of capital is the return foregone by investing in one project rather than in an alternative project. I.e., the cost of a project is the value of the next best alternative foregone. One alternative outside the public sector is investment in the share market. The share market is likely to be a good indicator of the next best alternative because the companies who make up the market are incentivised to search out the best investments in the economy, both locally and overseas, and because the government does in fact invest in the share market through the NZ Superannuation Fund and could choose to vary the amount invested.

Basing the discount rate on the opportunity cost of capital is sometimes criticised on the grounds that it assumes that markets are perfect. Two important and pervasive market imperfections are externalities and taxation:

- Externalities: There are two ways of taking account of externalities. One is to adjust the discount rate; the other is to take them into account explicitly in the individual cash flows. The latter is considered to be the better approach.
- Taxation: A tax on capital income reduces the amount of investment compared with a situation where there is no such tax. The volume of investment could therefore be considered to be sub-optimal. Using a post-tax rate of return as the public sector discount rate could therefore be regarded as correcting for, or avoiding, the market imperfection created by tax. We note, however, that using a pre-tax rate of return is equivalent to taxing public sector investments. The tax rate required to meet a given government revenue required is therefore lower than if only private sector investments were taxed. It is generally accepted that the deadweight cost of taxation increases exponentially with the rate of tax. A lower tax spread over a wider set of investments is therefore less distortionary than a narrower tax limited to private investments only.

We conclude that market imperfections do not provide sufficient reason to modify the discount rate.

Estimation of Crown's Opportunity Cost of Capital

The Crown's cost of capital cannot be estimated directly because it is a function of both the cost of borrowing and the cost of taxation, or more precisely the cost of the implicit taxpayer guarantee provided to support Crown borrowing. The Crown's cost of debt does not take into account project risk because the Crown can subsequently levy taxpayers to meet any shortfall on a project. The usual approach is therefore to estimate the expected return from alternative investments in the private sector, since that is likely to be a good

proxy for the Crown's cost of capital (subject however to grossing up the cost of capital for corporate tax, thereby generating similar decisions on project acceptance or rejection to those of the private sector). In any case, the pre-tax return from investments in the private sector also represents the opportunity cost of capital for public sector investments.

The real opportunity cost of capital has been calculated using a version of the tax-adjusted capital asset pricing model (CAPM). The formula is as follows³:

$$WACC^4 \text{ (real)} = [(1 + WACCn) / (1 + i)] - 1$$

Where:

$$WACCn = [RFR \times (1 - Tc) + (Ep \times \beta_a)] / (1 - Te)$$

WACCn is the nominal weighted average cost of capital and β_a is the asset beta⁵. The other variables and their assumed values are as follows:

Tc (corporate tax rate) = 30%

Te (effective tax rate) = 20%

Ep (equity risk premium) = 7%

RFR (risk free rate) = 6.4%

i (inflation rate) = 3%

The derived values for WACC (real) are:

β_a (asset beta)	WACC (real) ⁶	Applications
0.42	6.0%	Buildings
0.67	8.0%	Default
0.65	8.0%	Infrastructure
0.82	9.5%	Technology

³ Derived from Lally, M. 1998, 'Public Sector Cost of Capital: A Comparison of Two Models', *New Zealand Economic Papers*, vol.32 No.2, 195-212.

⁴ Weighted Average Cost of Capital.

⁵ The beta coefficient is a measure of the sensitivity of an asset's return to that of the market portfolio. A beta of one means that the expected return of the investment always moves with the market as a whole; a beta of zero means that the expected return of the investment is independent of the market. A beta of zero implies the risk premium is also zero. The weighted average beta of all stocks in a market equals one (same as the market beta); a profit-regulated utility has a low beta; selling the market index short has a beta of -1; gold stocks are thought to have negative betas; the market average asset beta is 0.67 (assuming leverage of 33%); taking a leveraged position in the market index leads to an equity beta of more than 1. The equity beta of Michael Hill Jewellers has been estimated at 1.18, that of Skycity at 0.91, that of Telecom at 1.02 and that of Vector Ltd at 0.55. The beta of an individual investment is estimated by analysing the historical total returns on that asset.

⁶ Rounded to nearest 0.5%.

The reasons for choosing the above values are as follows:

Tax

A public sector project either displaces a private sector project, or it has to be paid for by increasing the tax burden on the private sector. A discount rate equal to the pre-tax private sector rate of return therefore seems appropriate.

The corporate tax rate is currently 30%. What effective tax rate should be assumed? Ideally the tax consequences of a project should be modelled in order to determine the effective tax rate. In the absence of such work, we assume a figure of 20%, based on the following considerations: There are significant tax concessions in the New Zealand tax code, in particular no capital gains tax and a 20% loading on the depreciation deduction. Trading stock is taxed on realisation. A concession for R&D is also being introduced. In addition, some offshore transactions have a low tax rate (viz the approved issuer levy - AIL). As a result, the tax wedge is less than 30%. Also, a figure of 20% has been used previously.

Equity risk premium

Following a review of the domestic and international evidence including forward-looking risk premium models, Lally concluded that the risk premium is around 7%⁷. The Commerce Commission has been examining the arguments and obtaining evidence from experts and has concluded in its draft guidelines, which are currently out for consultation, that 7% is the best estimate⁸.

Risk-free rate

It is widely assumed that long-term government bond rates are a good proxy for the 'risk-free' rate of interest. 10 year NZ government bonds are currently yielding around 6.4%. Deducting the currently forecast inflation rate of around 3% results in a real risk-free rate of 3.4%. This compares with the historical average risk-free rate of 1.1%. We consider that we should use the 6.4% nominal rate or 3.4% real rate, as there are no indications that the current high rate is trending downwards.

Asset Beta

The usual process for estimating the appropriate asset beta of a project is to start by identifying firms whose activities are comparable to that of the project in question. For each such comparator, the equity beta is estimated from a time-series regression of its equity returns on to those of a proxy for the market portfolio (usually a share portfolio). Each such equity beta estimate is then converted to an estimated asset beta using the gearing formula $\beta_e = \beta_a[1+L/(1-L)]$, where L is equal to debt / (debt + equity), β_e is the

⁷ Lally, M 2007, *The Weighted Average Cost of Capital for Gas Pipeline Businesses*, and Lally M & Marsden A 2004, "Tax-adjusted market risk premiums in New Zealand: 1931 – 2002, *Pacific-Basin Finance Journal* 12 (2004) 291– 310. This is for the tax-adjusted CAPM, which is generally considered to be more appropriate for countries like NZ that have an imputation credit system. The equity risk premium in the 'standard' CAPM is lower.

⁸ There is a 2005 Treasury paper which concluded that the market risk premium internationally appears to be trending downwards towards 4%. See New Zealand Treasury, *The Market Equity Risk Premium*, May 2005. The 7% risk free rate used in this paper is calculated under a tax-adjusted CAPM and equates to 5% in the standard version of the CAPM. The 1% difference between that and the 4% in the 2005 Treasury paper could be attributed to the fact that the estimate of 4% is for a range of markets with particular emphasis on the U.S., which has a lower market risk premium than New Zealand.

equity beta and β_a is the asset beta. Since financial leverage generally changes over the typical five year period used to estimate the equity beta, the conversion to an asset beta should ideally use the average debt-equity ratio over that period. Having assembled a set of estimates for the asset beta of the project in question, averaging over these should then be undertaken to improve the statistical reliability of the estimate.

The estimated equity betas and the corresponding asset betas of some representative private sector firms are as follows⁹:

	Equity Beta	Asset Beta
Buildings (general purpose office):	0.6 ¹⁰	0.42 ¹¹
Transport companies:	0.85 ¹²	0.65 ¹³
Telecommunications:	1.03 ¹⁴	0.82 ¹⁵

Obviously this leaves a number of projects for which it is difficult to estimate a beta, e.g. a drug subsidy program, or defence investments. As a pragmatic solution, we suggest an asset beta of 0.67 which is the market average¹⁶.

⁹ We recognise that these numbers are not statistically robust, as they are based on very small samples of firms, but they are our best estimates given data and time limitations.

¹⁰ This is the weighted average equity betas of AMP NZ Office Trust (0.57), Kiwi Income Property (0.61) and Ing Medical Properties Trust (0.64).

¹¹ The companies in question had debt to debt+equity ratios of around 0.25, 0.35 and 0.22 respectively in mid 2007.

¹² Freightways has a beta of 0.85

¹³ The company in question had a debt to debt equity ratio of around 0.23 in mid 2007.

¹⁴ Cabletalk Group's equity beta was 1.29, Sky Network Television Ltd's was 1.03

¹⁵ The companies in question had debt to debt equity ratios of around 0.29 and 0.20 in mid 2007.

¹⁶ 0.67 corresponds to an equity beta of 1 if the average gearing is 33%. The average gearing was calculated by Bao, B. 2008, Estimation of the Leverage-Adjusted Market Risk Premium in New Zealand, Masters Thesis, Victoria University of Wellington.