Confidential

Discount Rate for the Grid Investment Test

Report to Transpower

August

2006

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1 Summary

Transpower asked Castalia to advise on the appropriate discount rate to use in the Grid Investment Test of Transpower's proposed Auckland Supply Upgrade. Following a careful analysis of the theory and of Transpower's proposed Upgrade, Castalia concludes that a real discount rate in the range of 2.72 to 4.18 percent is probably appropriate.

Our conclusion follows from the following five assumptions:

- The Grid Investment Test (GIT) is essentially a social cost-benefit analysis, not a private investment analysis
- The appropriate discount rate for a social cost benefit analysis is the Social Rate of Time Preference plus a factor to account for social risk aversion
- The best estimate of the real Social Rate of Time Preference is the post-tax real rate on long term government bonds. Government bonds currently yield 5.8 percent as a pre-tax nominal return, meaning that the real return in investors' hands post-tax is around 1.25 percent
- The best estimate of social risk aversion for the project is derived from the asset beta of companies which invest in and operate electricity and gas transmission companies in other OECD countries, multiplied by a market risk premium
- Tax is simply a transfer in a social cost benefit analysis, and therefore the discount rate should not be 'grossed up' for tax.

Our calculations are shown in Box 1 below.

In contrast, the Commission used a real discount rate of 7 percent, and tested the sensitivity of its calculations to discount rates of 5 and 9 percent. Our analysis shows that even the lower end of the range tested by the Commission was probably above the appropriate value for the discount rate.

The Commission based its choice of discount rate on feedback from market participants, and a report by Saha International. However, as we show in Section 6, Saha International did not in fact reach any clear conclusion on the appropriate discount rate, and what analysis was presented was muddled and based on out-of-date theory. In a nutshell, the main difference between our approach and that used by others, including Frontier Economics and Saha International, is our conclusion that since tax is simply a transfer from a cost-benefit point of view, it should not be included in the discount rate.

Box 1 : Calculation of the Discount Rate for Use in the GIT

In Castalia's view, the correct formula for calculating a Real Social Discount Rate is:

$$SDR = \frac{1 + (1 - T)R_f + B_a \times MRP}{1 + I} - 1$$

Symbol	Meaning	Value	Source
SDR	Social Discount Rate	2.72%–4.18%	Calculated
T	Corporate Tax	33.0%	Dominant NZ tax rate
R_f	Risk free rate (nominal)	5.8%	PWC CoC Report
B_a	Asset beta	0.2–0.4	International results
MRP	Market Risk Premium	7.5%	PWC CoC Report
I	Inflation	2.6%	Castalia, from inflation indexed bond yields

The derivation of this formula, and the figures used, is fully explained in the body of the report. The formula is based on a number of simplifications that are noted in the body of the report. Note that the formula is in real terms (adjusted for inflation) to be consistent with the costs and benefits in the Commission's model, which are also in real terms.

The range in values for the Real Social Discount Rate comes from the range of possible betas. We have not attempted to estimate where in this range Transpower's true beta lies. Certainly no one should assume that the mid-point is the 'best' estimate—this would be naïve and simplistic. On the contrary, our intention is simply to show that with a wide range of plausible betas the Real Social Discount Rate is below even the lower bound of the range used by the Commission.

Source: Castalia

2 Overview of the Analysis

In deciding which discount rate to use we need to know what we are using it for. In particular, is it for a social cost-benefit analysis, or a private investment decision? It seems that the GIT is intended to be a social-cost benefit analysis (see our argument in Section 3).

In a social cost benefit analysis, the starting point for estimating the discount rate is the Social Rate of Time Preference (SRTP). Section 4 reviews a range of possible measures of the social rate of time preference, and concludes that the rate on long term New Zealand Government bonds is the most suitable.

For a risk free project the Social Rate of Time Preference would be the appropriate discount rate. But the Auckland Supply Upgrade (the Upgrade) has risks and risk-bearing has a cost. The Capital Asset Pricing Model (CAPM) provides the standard way of thinking about the cost of risk. Using the CAPM framework we argue that the social aversion to bearing such risk is best measured by the Market Risk Premium. The Market Risk Premium is the difference between the average return on the stock market and the return on an essentially risk free investment like New Zealand Government bonds. The riskiness of the project is best measured by the 'asset beta' for comparable transmission companies. Evidence from overseas indicates that transmission businesses are relatively low risk, with asset betas in the range 0.2 to 0.4. As a result, the risk premium is relatively modest. These points on risk are made in Section 4.1.

In Section 5 we show that our derivation of the Real Social Discount Rate results in the same formula as standard corporate finance result for a real post-tax Weighted Average Cost of Capital (WACC). Two different concepts—the corporate cost of capital and the appropriate social discount rate—converge in the same number. This convergence between the concepts means that in a pragmatic sense we are largely on common ground with the previous advisors in this area who advocated a discount rate derived from a corporate finance WACC.

The key difference between our result and that which went before is that our formulation is equivalent to Transpower's *post-tax* WACC, while the Commission used Transpower's *pre-tax* WACC as the discount rate. The question is why previous work assumed a pre-tax WACC. In Section 5.2 we show that WACC is fundamentally a post-tax concept. The cost of capital is the return investors demand for providing their money, and investor returns are necessarily post-tax. In private sector corporate finance and investment appraisal work, the rigorous approach is to incorporate actual tax payments in the cashflow estimates, and then discount the post-tax cashflows at a post-tax WACC. However, it can be difficult to forecast actual tax effects of individual projects. For this reason it is common in private sector project analysis to simplify things by adding tax as a margin to the discount rate, instead of subtracting tax from the cashflows. Adding tax to the discount rate converts the observable post-tax WACC into an approximate 'pre-tax' WACC.

We assume that a pre-tax WACC was used as a discount rate simply because of this common practice in corporate finance. But on closer analysis this seems misguided. In a social cost benefit analysis, tax is simply a transfer; what appears as a cost to the company on the one hand is a benefit to the rest of society (through the goods and services the tax funds) on the other. Therefore the tax should not appear in the calculations at all, either in the costs and benefits, or in the discount rate.

In Section 6 we review the previous work on setting a discount rate for the GIT. We look first at the Commission's own reasoning, noting that the Commission used 7 percent simply as a convenient initial value, subject to further work. The Commission asked Saha International to advise on the discount rate, but Saha International did not really develop a firm estimate, but simply concluded that the Commissions expressed preference for using Transpower's WACC was a reasonable approximation. However, even this conclusion was based on outdated closed-economy models for choosing social discount rates, and the mistaken belief that somehow Transpower has non-commercial roles that would have lowered estimates of Transpower's WACC. Frontier Economic advocated a discount rate higher than 7 percent, apparently in the belief that using a lower discount rate would distort investment choices between transmission and generation. We show that this fear is unwarranted.

3 The GIT is a Kind of Social Cost Benefit Analysis

The Grid Investment Test (GIT) is essentially a social cost benefit analysis, not a private investment analysis. From this it follows that the appropriate discount rate is a social discount rate. The social discount rate may be different from the rate a private investor would use.

Social cost benefit analysis and private investment analysis are similar. Both involve forecasting streams of costs and benefits, discounting these back to a Net Present Value, and choosing the option with the highest positive Net Present Value.

While similar, social cost benefit analysis and private investment analysis are not the same. Clearly, in a social cost benefit analysis the costs and benefits identified are those accruing to society as a whole (and include both financial and non-financial costs and benefits). In a social cost benefit analysis, the discount rate used should reflect social preferences. In contrast, a private investment analysis considers only the financial costs and benefits accruing to the entity concerned, and uses a discount rate based on the cost of capital faced by that entity.

Part F of Electricity Governance Rules makes it clear that the GIT is not a private investment analysis. The costs and benefits considered are not simply those accruing to Transpower or any other single entity. Rather, costs and benefits for all market participants are to be considered. Moreover, the types of benefits to be included go beyond financial benefits to Transpower to include benefits which are not subject to market transactions, such as changes in the value of involuntary demand curtailment.

The GIT is not exactly the same as a conventional social cost benefit analysis, in those only costs and benefits accruing to 'those persons who produce, distribute, retail and consume electricity' are considered.[1] This definition includes almost everyone in New Zealand, so on a literal reading the people to be considered in the GIT are almost exactly the same as those who would be considered in a national cost benefit analysis. However it may be the intention of the test that benefits and costs are to be considered only to the extent that they accrue to people directly as a result of their participation in the electricity market, and not indirectly through non-electricity market interactions. If this were the case, the range of costs and benefits to be considered in the GIT would be limited compared to a conventional social cost benefit analysis. Despite this possible difference, the intention of the GIT is clearly to consider costs and benefits at the social, rather than private, level.

We note that Frontier Economics shared this view in its report to the Commission on the Draft Grid Investment Test, as the quotation below shows.

> *2.2 GIT AS A COST BENEFIT ANALYSIS*
>
> *The GIT objectives outlined in Part F of the Transport Rules suggest that the test should incorporate a form of cost-benefit analysis. This approach aims to ensure that only investments that are net beneficial to the market are undertaken.*

[1] *Electricity Governance Rules*, Part F cl. 23 and 27

Broadly speaking, cost-benefit analysis involves comparing a potential investment project with the situation when the project is not undertaken (the base case) to determine whether the project offers overall net benefits. The difference between discounted benefits and discounted costs – the net market benefit – is an indication of how valuable an investment project is to society and whether it should be undertaken.[2]

[2] *Draft Grid Investment Test: Final Draft Discussion Paper 2004,* Frontier Economics – Page 3

4 Estimating the Appropriate Social Discount Rate

Since it is possible that the discount rate appropriate for a social cost benefit analysis may be different from that appropriate for a private cost benefit analysis, we use the term Social Discount Rate to refer to the discount rate appropriate for use in a social cost benefit analysis. Because the costs and benefits in the GIT are in real terms (that is, they do not include expected inflation) we focus on derivation of a real Social Discount Rate.

In this section we argue that the Social Discount Rate should be calculated as the sum of two elements:

- The Social Rate of Time Preference, and
- A factor to account for social risk aversion, or the cost to society of bearing risk. We term this the Social Cost of Risk Bearing.

The following sections show how the Social Rate of Time Preference and the Social Cost of Risk Bearing can be estimated.

4.1 Estimating the Social Rate of Time Preference

This section estimates the Social Rate of Time Preference. The Social Rate of Time Preference is the amount by which people prefer consumption now to consumption in the future. This Social Rate of Time Preference is best estimated from observable market interest rates, since these interest rates reveal people's preference for advancing consumption (borrowing) or delaying consumption (saving). There are many different observable interest rates, and it is not clear which one is the best reflection of the social rate of time preference. The common approach in the literature is to use the interest rate on government bonds as an indicator of the Social Rate of Time Preference. Adopting this approach gives us a social rate of time preference of 5.8 percent (in nominal, pre-tax terms).

It is well understood that a key reason for using the discount rate is to reflect people's preferences for consumption now over consumption in the future. For example, Frontier Economics say that

> *Discount rates are applied to expected cashflows in cost-benefit analysis on the basis that a dollar today is preferred to a dollar tomorrow, even leaving aside expectations of inflation.*[3]

The Saha International paper for the Commission on discount rates similarly argues that

> *Discount rates reflect an opportunity cost in both the private and public sector context. This opportunity cost comprises two elements:*
>
> - *Time preference (utility of current consumption versus future consumption); and*
> - *Compensation for risk (uncertainty about the future requires greater expected return).*[4]

This amount by which we prefer consumption now over consumption in the future is known as the 'rate of time preference'. Each individual has a rate of time preference. Savers are prepared to sacrifice present consumption in order to save and therefore to enjoy greater consumption later – or to enable their children to inherit and enjoy their

[3] *Draft Grid Investment Test: Final Draft Discussion Paper 2004* - Frontier Economics – Page 27

[4] *Discount Rate for Application in Grid Investment Tests* - Saha International November 2004 Page 23

savings later. On the other hand, borrowers are choosing to bring their consumption forward.

The various rates of time preference interact in the market for saving and borrowing. Those with relatively high rates of time preference will choose to borrow, while those with low rates of time preference will save, lending money to those who wish to borrow. These interactions will establish a market interest rate. Once a market interest exists, people will adjust their behaviour based on the market rate, borrowing or lending just enough at the market rate to best satisfy their personal preferences between consumption now and consumption later. It follows from this that observable market interest rates are our best estimate of the Social Rate of Time Preference.

The Social Rate of Time Preference then is a measure of society's preference for consumption today over the same level of consumption at a later date. It reflects society's preference to consume sooner rather than later – an impatience effect. It can be expressed as the rate of return, r, needed to make society indifferent between consuming X today and consuming X(1 + r) in a period's time.

In analysing the SRTP, some economists have argued that it contains two elements: one reflecting a pure rate of time preference for consumption; and another reflecting the decreasing value or utility of consumption the longer it is delayed. It is assumed that by the time the delayed consumption occurs the economy will have expanded, and individuals will derive lower value or utility from a given level of consumption than at present. This approach leads to a formula:

$$SRTP = p + u.g$$

where: p = pure time discount rate

u = elasticity of marginal utility of consumption

g = projected long run growth rate of real consumption per capita.

The UK Green Book indicates that the UK has used this approach in the derivation of its discount rate. Their computation is SRTP = 1.5 + 1.0 x 2.0 = 3.5 %. The calculation gives a higher result for countries where utility gains from increased consumption and growth rates are higher than in the UK.

The more common approach, however, is to view market interest rates as the equilibrium of private rates of time preference. In this sense, the market interest rate reveals people's rate of time preference, at the margin. We think that using the market interest as an observable measure of time preference is the better method.

There are a range of interest rates in the market, raising the question of which rate to use. Since we want to separate the Social Rate of Time Preference from the cost of risk-bearing, we need an interest rate which does not include a risk-component. This leads us to use the rate on New Zealand Government bonds. Government bonds are the lowest risk savings instrument widely available to New Zealanders. A long term bond rate is appropriate for long term decisions, such as the Upgrade. The rate on long term New Zealand Government bonds is 5.8 percent (pre-tax nominal).[5]

This pre-tax nominal return needs to be adjusted both for tax and inflation. While the Government pays a rate of 5.8 percent, tax is deducted from the interest payments in the hands of the saver. This means that the interest rate received by the saver is less by the

[5] PricewaterhouseCoopers March 2006. We use the risk free rate in this report to be consistent with our later use of this report's estimate of the Market Risk Premium.

amount of tax. If we assume a typical marginal tax rate of 33 percent, we can calculate a post-tax nominal interest rate of 3.89 percent.[6]

It might be argued that some New Zealanders are net borrowers, not savers. People who borrow for personal consumption do not get a tax credit on their interest payments. If we took a borrower's perspective, then the rate of time preference would be 5.8 percent, not 3.89 percent.[7] In other words, the need to pay income tax drives a wedge between the interest rate which borrowers pay and the rate which lenders receive (see Figure 4 in Section 5.2 for an illustration of this effect). We therefore need to make a choice whether to use the rate faced by borrowers or the rate faced by savers, if we are to pick a single number for the Social Rate of Time Preference.

Most New Zealanders are net savers

The choice of whether to adopt the borrowers or the savers perspective depends on whether more New Zealand households are net borrowers or net savers. The best approach is to consider whether most New Zealand households have positive net wealth (by net wealth we mean total assets minus total liabilities). Figure 1 reports median net worth for both single (non-partnered) people, and for couples. Both are positive. Clearly, most New Zealanders have positive net worth, that is, they have saved more than they have consumed.

Figure 1: Average Net Worth

Economic unit	Median net worth $	Mean net worth $
Non-partnered individuals	10,300	97,900
Couples	172,900	322,300

Source: "The Net Worth of New Zealanders, a Report on Assets and Debts" Statistics New Zealand and the Retirement Commission p20

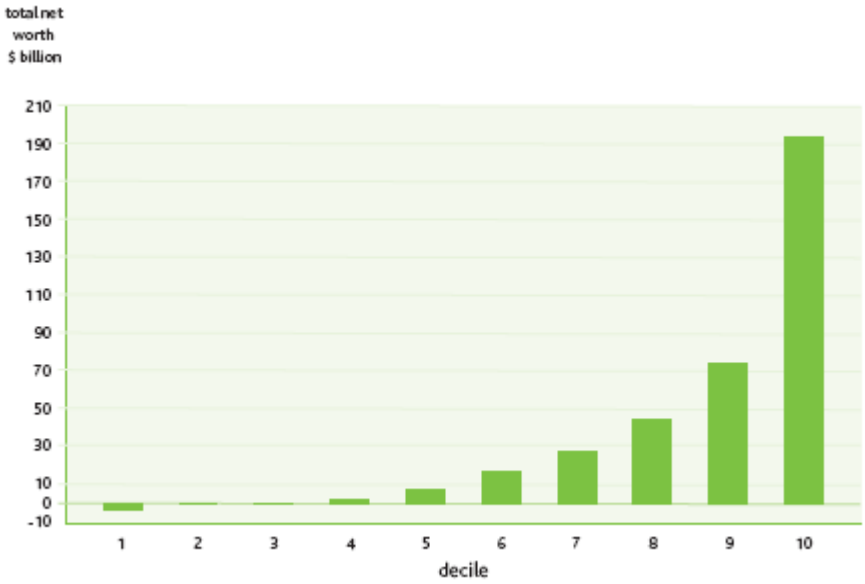
Figure 2 presents the distribution of total net worth by wealth decile. This shows that in fact over 80 percent of New Zealand economic units[8] have positive net worth. The net worth figures are probably understated, since they exclude trust assets and intangible assets such as education.

[6] Calculated as 5.8% x (1-0.33) = 3.89%

[7] Of course borrowers in fact face rates well above 5.8 percent. However, the difference between the premium which a household pays above the government for borrowing is a product of the greater risk involved in lending to a household. We deal with risk in the next section. In this paragraph we want to focus simply on the question of whether the Social Rate of Time Preference should be a pre- or post-tax number.

[8] 'Economic units' means non-partnered individuals and couples. It's similar to 'household'.

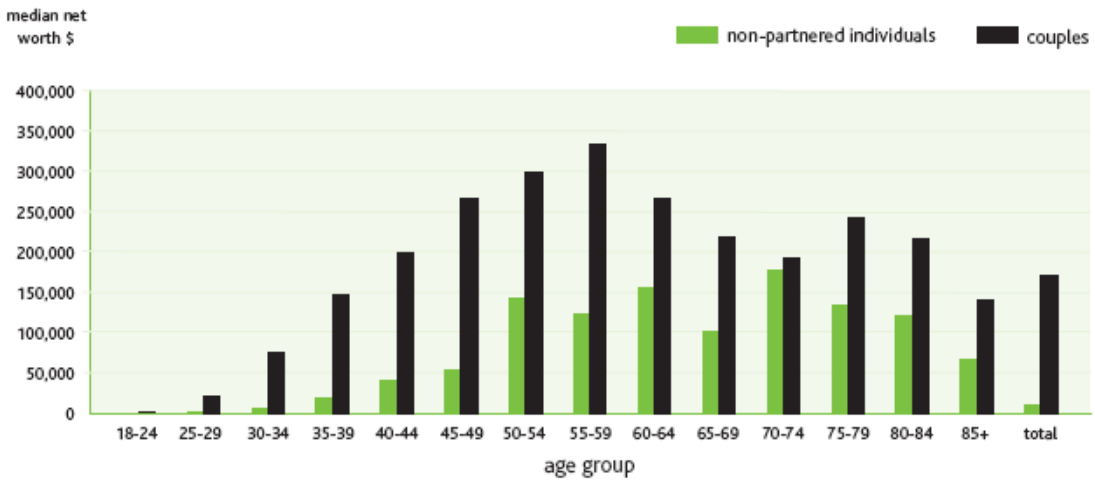
Figure 2: Net Worth of New Zealanders by Decile



Source: "The Net Worth of New Zealanders, a Report on Assets and Debts" Statistics New Zealand and the Retirement Commission p22

Most of the people with negative net worth are young, as Figure 3 shows. The low reported net worth for young people is due in part to student loans. About 40 percent of people aged 18 to 24 have student loans. The education funded by the loan is presumably more valuable than the money borrowed to fund it. This suggests that many of the economic units reporting negative net wealth are in fact savers, but their accumulation of savings has been in the form of an investment in education.

Figure 3: Net Worth by Age



Source: "The Net Worth of New Zealanders, a Report on Assets and Debts" Statistics New Zealand and the Retirement Commission p20

Recent figures suggest the net wealth of the New Zealand households is higher than the Statistics New Zealand figures indicate. The mean household net wealth in 2006 was

$341,500 according to Spicers Wealth Management. This was $42,500 higher than the year before, largely as a result of rising house prices.[9]

So it seems that most New Zealand households are saving for the future on balance, and hence a saver's perspective is appropriate for our estimate of the Social Discount Rate. Using the post-tax interest rate on Government bonds is in line with mainstream academic writing in the area.[10]

Adjustment to a real discount rate

The interest rate of 3.89 percent is in nominal terms. That is, it includes an allowance for expected inflation. To be consistent with the approach taken in the GIT, this rate needs to be adjusted by taking out the inflation component. We derived a forecast inflation rate of 2.6 percent by comparing the interest rates on inflation indexed government bonds with the rate on non-inflation indexed bonds of similar maturity.[11] Removing this inflation component gives us a real post-tax interest rate of 1.25 percent.[12] In other words, the real interest rate which New Zealand savers receive is in the region of 1.25 percent. This is the best available estimate of the Social Rate of Time Preference.

Summary on the Social Rate of Time Preference

In summary, we follow the conventional practice of using the interest rate on long term government bonds as an indicator of the Social Rate of Time Preference. The real pre-tax interest rate is 5.8 percent. We deduct tax and inflation from this rate to give the post-tax real rate which lenders actually receive. This is currently 1.25 percent.

4.2 Adding a Risk Premium to the Social Rate of Time Preference

People are risk averse, so discount rates for risky projects should be higher than for non-risky projects. The best estimate of the cost of risk-bearing for a project comes from the Capital Asset Pricing Model. In this model, the Market Risk Premium (currently estimated at 7.5 percent) is a convenient estimate of New Zealanders' risk aversion, while the 'beta' is a measure of the relative risk of any particular investment. International evidence suggests that betas are relatively low for transmission investments, probably in the range of 0.2 to 0.4. Multiplying the Market Risk Premium by the asset beta gives a risk premium for the Upgrade in the region of 1.5 to 3.0 percent. This needs to be added to the social rate of time preference to calculate the Social Discount Rate appropriate to the Upgrade.

To take this argument step by step, we start with the observation that most people prefer certain returns to risky ones. So if future returns are risky, people will discount them at a higher rate than if those returns were certain. Since the Upgrade is risky—that is, actual costs and benefits of the Upgrade could differ from those forecast—the discount rate used in the GIT should be increased above the Social Rate of Time Preference by an amount which reflects social risk aversion.

The question therefore is how to set the appropriate risk premium to add to the Social Rate of Time Preference to get a Social Discount Rate for use in the GIT. The best

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[9] Household Savings Indicators, Spicers, June 2006. NB The fact that the average household wealth is positive does not prove that the median household is a net saver, but it seems likely.

[10] See for example Liu, Liqun "The Multi-Period Cost-Benefit Rule with Mobile Capital and Distorted Labor" *International Tax and Public Finance*, 2005

[11] (1.0595/1.0327 – 1) x 100 = 2.6% where 5.95% is a yield on a standard Government Bond and 3.27% is a yield on the inflation adjusted Government Bond. Figures used are from February 2006

[12] (1+0.0389)/(1+0.026)-1

framework available is provided by the Capital Asset Pricing Model (CAPM). The CAPM estimates the cost of risk bearing by observing the difference between returns on (risky) share-market investments, and (relatively risk-free) long term government bonds. This difference is known as the 'Market Risk Premium'. The Market Risk Premium in New Zealand is currently estimated at 7.5 percent.[13] This is the best available estimate of the amount New Zealanders need to receive to persuade them to accept the level of risk inherent in a diversified sharemarket investment, rather than earn a safe return on Government bonds.

The next step is to derive a measure of the riskiness of the Upgrade relative to a diversified sharemarket investment. In the CAPM framework this relative riskiness is measured by 'beta'. Beta is related to the covariance of returns on the asset in question with the returns on the stockmarket. An asset with a beta of one has the same level of risk as a diversified investment in the stockmarket, and so logically people will demand the Market Risk Premium as compensation for the risk involved in holding that asset. Similarly, an asset with a beta of 0.5 is half as risky as a diversified sharemarket investment, and so people will demand a premium equal to half the Market Risk Premium to hold such an asset.

The question therefore is 'what beta value would be an appropriate measure of the riskiness of the Upgrade'. Beta values are generally only available for companies listed on a stock exchange. It is not practical to try to calculate a beta for the Upgrade directly, or even for Transpower as a whole. The best, reasonably feasible approach is to use betas for similar listed companies. Doing this involves an assumption that the riskiness of the Upgrade is similar to the riskiness of transmission businesses in other countries.

Evidence on beta values for transmission and similar companies

Some of the best recent evidence on betas for transmission businesses comes from Britain. Three companies in Britain operate transmission businesses. These companies are:

- National Grid Plc., which operates the English national electricity transmission grid and the British national high pressure gas transmission grid, as well as related businesses
- Scottish Power Plc, which operates an electricity transmission grid in Scotland and other businesses
- Scottish and Southern Plc., which operates a different electricity transmission grid in Scotland and other businesses

The British electricity and gas regulator, Ofgem, commissioned the City firm Smithers and Co, together with Stephen Wright of Birkbeck College, to calculate equity betas for these firms (and a number of other utilities). Table 1 summarises their findings on equity betas. An equity beta is a measure of the riskiness of an investment in the equity of a company.

[13] *The Cost of Capital Report* PricewaterhouseCoopers March 2006

Table 1: Beta Estimates for British Transmission Companies

UK Listed Company	Transmission Providers Owned	Equity beta	Gearing estimate	Asset beta estimate
National Grid	National Grid Electricity Transmission plc National Grid Gas plc	0.6	0.47	0.318
Scottish Power	Scottish Power Transmission Limited	0.6	0.34	0.396
Scottish and Southern Energy	Scottish Hydro-Electric Transmission Ltd	0.5	0.18	0.41

Source: Equity beta from S. Wright and Smithers and Co. 2004. Gearing is an approximation using market value of equity on 10 August 2006 and total debt from 2005/06 annual reports

Companies are financed by a mix of debt and equity, and since debt holders get fixed returns while equity holders are residual risk bearers, equity returns are more risky than the returns of the company as a whole. To get an estimate of the riskiness of the business as a whole (as opposed to just the equity in the business) we need to transform the equity beta into an asset beta. We do this simply by multiplying the equity beta by one minus the company gearing, where gearing is defined as the proportion of debt in the enterprise value of the company.

Smithers and Wright did not calculate asset betas, so we have approximated them. We used the current gearing for this calculation. The results are shown in Table 1. We acknowledge that our approach is over-simplified. The correct approach would require an estimate of gearing for each period over which the beta is estimated. However, while further refinements are certainly possible and desirable, we have no doubt that the asset betas in Table 1 are a reasonable approximation of the riskiness of a transmission business in Britain. The asset beta estimates are in the range 0.31 to 0.41. As one would expect, the asset beta is lowest for National Grid, which has the greatest concentration on transmission in its portfolio of businesses. Scottish Power and Scottish and Southern Energy earn a greater share of their returns from riskier businesses such as generation and retail, and hence have higher betas.

In Australia, the Australian Competition and Consumer Commission (ACCC) has used beta estimates in setting price caps for a number of transmission businesses over the last five years. The regulated businesses include the Victorian electricity grid, Transgrid (the largest transmission operator in New South Wales and the Australian Capital Territories), and the Murraylink Interconnector. In all of these decisions the ACCC has assumed an asset beta of 0.4 for transmission businesses.

Betas for Australian transmission businesses are not directly observable since there are no listed electricity transmission businesses in Australia. However, the ACCC has considered evidence of betas for electricity and gas distribution companies in Australia. The most recent such data is presented in Table 2. The table gives gearing, equity beta,

and unlevered (asset) betas for several listed energy utilities. The average equity beta is 0.29, with an average estimated asset beta of 0.1. This lead the ACCC to comment that the data "suggest that the ACCC has been conservative with its estimate of the equity beta in its previous regulatory decisions."[14]

Table 2 : Australian Utility Betas

December 2004 AGSM data

Company	Gearing level	Unadjusted B_a	De-levered B_a
Australian Pipeline Trust	66.4	0.44	0.15
Envestra	80.8	0.41	0.08
AlintaGas	56.2	0.4	0.18
Australian Gas Light	36.5	0.03	0.02
GasNet	68.9	0.18	0.06
Average	61.76	0.29	0.1

Source: NSW and ACT Transmission Network Revenue Cap TransGrid 2004-05 to 2008-09 by ACCC 27 April 2005, based on December 2004 data from the Australian Graduate School of Management (AGSM). For calculation purposes, the ACCC has had regard to raw (unadjusted) beta estimates, the debt beta was set at zero, and the corresponding gearing levels were from Standard and Poor's.

Finally we note that Professor Martin Lally presented evidence on asset betas in his paper for the New Zealand Commerce Commission estimating the cost of capital for electricity lines business in New Zealand.[15] Aspects of Professor Lally's paper were rightly criticised in a subsequent paper[16], but we nevertheless consider that the following observations from Lally's paper are worth repeating:

- The three New Zealand electricity distribution businesses for which data was available had asset betas in the range -0.10 to 0.48, with a median of 0.10[17]
- Considering a range of US electricity and gas utilities, over a variety of periods and using various data sources, Lally finds asset betas between 0.06 and 0.35[18]
- After considering a wide range of international evidence, Lally recommended use of an asset beta of 0.4.[19]

Our point here is not to establish Transpower's exact asset beta. But is seems clear that the available data on similar businesses in New Zealand, Australia, the UK and the USA suggest asset betas in the range 0.2 to 0.4. Moreover, these observable betas are generally for companies whose businesses extend beyond transmission to include riskier components, such as generation, retail and contracting. This suggests that the companies observed are likely to be riskier than a pure transmission investment like Transpower. So while there is plenty of scope to debate the exact beta estimate which would be

[14] *NSW and ACT Transmission Network Revenue Cap TransGrid 2004-05 to 2008-09*, ACCC 27 April 2005

[15] Lally, *The Weighted Average Cost of Capital for Electricity Lines Business* 2005

[16] Boyle, Evans and Guthrie, *Estimating the WACC in a Regulatory Setting* 2006

[17] Lally 2005 Table 2, p.40

[18] Lally 2005 pp.41 to 42

[19] Lally 2005 pp.47

appropriate for Transpower in general or the Upgrade in particular, the evidence clearly supports the view that it is reasonable to believe the true number may lie between 0.2 and 0.4.

In establishing this range we are not making any judgement about where within this range Transpower's beta lies. We have simply taken the highest plausible value and the lowest plausible value. Much more work would be required to determine the appropriate value more precisely and there is no reason to assume that the true value lies in the middle of the range.[20] For example, one could argue that the best comparator to Transpower would be one of the UK regulated transmission operators. Their betas are in the range 0.31 to 0.4. The UK regulator assumes a beta of 1 when resetting transmission price controls, while the ACCC uses a beta of 0.4. Our point is not to establish what Transpower's beta is, but simply to point out that a wide range of plausible estimates of beta all produce a social discount rate below that used by the Commission.

Calculating the Risk Factor to Include in the Discount Rate

Putting together the market risk premium and the asset beta we can derive a risk factor in the region of 1.5 to 3.0 percent. This range comes simply from multiplying the Market Risk Premium of 7.5 percent by beta estimate of 0.2 and 0.4 respectively.

4.3 Putting the Components Together

The theory tells us that the correct discount rate should reflect the Social Rate of Time Preference, plus an allowance for risk. We can therefore derive the appropriate real Social Discount Rate for the Upgrade by adding our risk premium range of 1.5 to 3.0 percent to a real Social Rate of Time Preference of 1.25 percent.

$$\text{Nominal } SDR = (1-T)R_f + B_a \times MRP$$

$$\text{Real } SDR = \frac{\text{Nominal } SDR}{1+I} - 1$$

Symbol	Meaning	Value	Source
SDR	Social Discount Rate	2.72%–4.18%	Calculated
T	Corporate Tax	33.0%	Dominant NZ tax rate
R_f	Risk free rate (nominal)	5.8%	PWC CoC Report
B_a	Asset beta	0.2–0.4	International results
MRP	Market Risk Premium	7.5%	PWC CoC Report
I	Inflation	2.6%	Castalia, from inflation indexed bond yields

[20] This kind of simplistic reasoning was rightly criticized in "Estimating the WACC in a Regulatory Setting" Boyle, Evans and Guthrie 2006

This gives an estimate of the real Social Discount Rate in the range of 2.72 to 4.18 percent. Let us repeat this. The appropriate real discount rate to use in the GIT is probably in the region 2.72 to 4.18 percent.

5 The Social Discount Rate is the Post-Tax WACC

The Social Discount Rate formulation we recommend is the same as the conventional formulation of a private discount rate or WACC for a comparable investment. The only significant difference is that tax enters a private analysis as a cost, while in a social cost benefit analysis tax should not be considered as a cost. This section:

- Shows that our formulation of the Real Social Discount Rate is the same as the formulation of a private post-tax real WACC
- Explains why tax should not be considered in a social cost benefit analysis, and hence that it is incorrect to use a pre-tax WACC as an estimate of the Social Discount Rate
- Briefly discusses the relationship between the discount rate and the appropriate figure to use in estimating a reasonable rate of return.

5.1 The Equivalence of the Real Social Discount Rate and the Post-Tax WACC

We have derived the social discount rate from first principles, using people's observable preferences for consumption now rather than in the future, and their observable levels of risk aversion.

The alert reader will already have spotted, however, that our formulation of the appropriate social discount rate for the GIT is essentially the same as a conventional formulation of Transpower's tax real WACC.[21]

$$\text{Nominal } SDR = (1-T)R_f + B_a \times MRP = WACC$$

This similarity follows from the fact that both the cost of capital and the social discount rate are the product of people's preferences interacting in the market. The underlying preference for consumption now over consumption in the future, which we are interested in for a social cost benefit analysis, is the very thing which gives rise to a market interest rate. The market interest rate sets the rate companies need to pay to attract funds for low risk ventures.

Similarly, people's underlying risk aversion leads them to demand higher returns for taking higher risks. This leads to the observed market risk premia, and the risk component that companies must pay to attract capital to risky ventures. These same risk premia are the best indicators of the social cost of risk bearing, which is what we are interested in from the perspective of a social cost benefit analysis.

5.2 Why Tax Should Not Be Included in the Social Discount Rate

In the previous section we showed that the formula for the real Social Discount Rate applicable to the GIT is equivalent to the formula for Transpower's real *post-tax* WACC. However, the Commission has so far used a discount rate equal to Transpower's estimate of its real *pre-tax* WACC. In this section we show that the appropriate discount rate is the post-tax WACC.

The post-tax WACC is the return providers of capital actually receive. Therefore the post-tax WACC is the rate which drives suppliers of capital. When private companies are analysing investments, the best approach is to include tax payments in the

[21] The formula is the same for both except for the minor effect of Transpower debt risk premium

cashflows.[22] Including tax in the cashflows means that the cashflow forecasts will accurately reflect the cash that suppliers of capital will receive. This cashflow can then be correctly discounted at the post tax WACC.

While the theoretically correct approach is to use post-tax cashflows and a post-tax WACC, this can be difficult in practice. In particular, when an analyst is forecasting the cashflows for a particular project, it can be onerous to calculate the incremental effect of the project on a company's tax liabilities, since these may vary as a result of non-project factors such as the level of tax-losses that are available from other businesses in the group or that have been carried forward from previous years. In these circumstances, it is common in private sector project analysis to simplify things by adding tax as a margin to the discount rate, instead of subtracting tax from the cashflows. Adding tax to the discount rate converts the observable post-tax WACC into an approximate 'pre-tax' WACC.

Similarly, in regulatory settings a pre-tax WACC is often used when setting price-caps. A regulator may not want to make judgements on the actual tax costs a company is likely to incur. Making such judgements could require the regulator to form a view on the appropriateness of a company's tax management strategies. Many regulators are reluctant to do this. For this and other reasons regulators sometimes prefer to add tax as a margin to the required rate of return, rather than take the more accurate approach of modelling tax in the company cashflows.

It may be that these precedents from project analysis and regulation influenced the Commission's decision to use a pre-tax WACC. But closer inspection reveals that such precedents are not a good guide to the correct approach to take in a social cost benefit setting.

Adding an allowance for tax to the discount rate is simply a shortcut to avoid having to calculate actual tax payments in the cashflow streams. If the costs and benefits assessed in the GIT were supposed to include tax as a cost, but for some reason it was difficult to calculate this cost, then it would be reasonable for the Commission to omit the taxes from the cost and benefit forecasts, and instead include an allowance for tax in the discount rate. However, taxes are not supposed to be included in the GIT as a cost. So the common corporate finance justification for adding an allowance for tax to the discount rate does not hold.

In fact, it is clear from GIT that tax is not meant to be included in the analysis at all. Tax is not listed as an item to include in calculating the cost of a project.[23] Nor is tax listed as a benefit. In fact, tax could not realistically be calculated as a reduction in net benefits, since most of the benefits to be considered are non-market, and therefore would not be taxed.

The fact that tax is not to be considered in the GIT follows from the GIT's role as a social cost benefit analysis (see Section 3). In a social cost benefit analysis, tax is simply a transfer. Tax may be a cost to a company. But the rest of society benefits by an off-setting amount, through the goods and services the tax funds.[24] Therefore in a social cost benefit analysis, tax should not appear in the calculations at all. The Electricity

[22] Copeland Koller and Murrin, *Valuation* 2000 p.201

[23] Part F Schedule F4 cl.23

[24] At least as a first approximation. In reality the deadweight losses and transaction costs of tax collection mean that taxes do impose some real cost on society

Commission correctly did not attempt to include tax in the cost and benefit forecasting. Equally, there is no reason to include an allowance for tax in the discount rate.[25]

5.3 Relationship between the Social Discount Rate and Allowed Returns for Transpower

Note that these arguments do not prejudge what Transpower or other lines companies should be able to earn on regulated investments. There are number of arguments including those related to real options, the asymmetry of the distribution of returns on regulated investments, and the practices of overseas regulators, which mean that the CAPM formulation of WACC may not be the only consideration in setting regulated returns. But these issues are not relevant to the choice of discount rate in the GIT.

The conclusion is that the question of the appropriate GIT discount rate and the allowed rate of return for regulatory purposes need to be decoupled. This may not be an ideal outcome, but it follows from the decision to impose the Grid Investment Test as an element of transmission regulation in New Zealand.

[25] There could be an argument in some circumstances for moving the social discount rate closer to a corporate pre-tax rate where public and private investments are substitutable. In such cases, using the pure Social Discount Rate might distort choices as to which investments should be made by the public sector and which by private firms. However, that argument does not apply in this case, for reasons which we explain in Section 6.2.3 in our comments on Frontier Economics' analysis.

6 Comparison with Previous Papers on the Discount Rate

Our estimate is that the appropriate real Social Discount Rate lies in the region 2.72 to 4.18 percent. This estimate is lower than the 7 percent discount rate used by the Commission. It is important to explain so far as possible how this difference arose.

In this section we review the reasoning behind the Commission's choice of 7 percent as the discount rate, and papers prepared by Frontier Economics and Saha International that may have influenced thinking on this topic. We find that none of the papers reviewed actually conclude that 7 percent is the appropriate discount rate. However, they do indicate or assume that a number in this region is likely to be appropriate. We show below where these arguments are mistaken.

6.1 The Commission Decision on Discount Rate

In its paper "Grid Investment Test—Explanatory Document"[26] the Commission explains its decision to use a 7 percent discount rate. It says

> "*The Commission has decided to adopt Transpower's suggestion of a 7% pre-tax real rate as an initial value, and test the sensitivity of the results to alternative discount rates. Clause 14 provides for the Commission of revise the discount rate at a later date."*[27]

Clearly the Commission is using 7 percent as an initial value, subject to revision. In other words, the Commission did not hold that 7 percent is the right number, but simply that 7 percent is the number it will use to start with.

There were a number of good reasons for the Commission to take this approach:

- Transpower had suggested the use of 7 percent, on the basis that this was an estimate of the company's pre-tax WACC. Transpower itself said that, given the Commission's timetable, a 'pragmatic' approach was required to setting a discount rate, and that ultimately the Commission should endeavour to establish a number of discount rates to be applied to the cost and benefit streams of various investments[28]
- There was no clear consensus from other submitters that the discount rate should be higher or lower, and most suggested that more research was required to determine the right discount rate[29]
- SAHA International was engaged to advise the Commission on discount rates, but the report did not in fact justify a particular number (see Section 6.2)
- The Commission thought that the choice of discount rate would be "unlikely to have a significant impact on GIT decisions".[30]

[26] Electricity Commission 3 December 2004 p.19

[27] Electricity Commission 3 December 2004 p.20

[28] Transpower submission on the GIT. para. 82 to 84

[29] Electricity Commission 3 December 2004 p.19

[30] Electricity Commission 3 December 2004 p.20

We now know that the choice of discount rate can influence the choice between options, which explains Transpower's request to Castalia to consider the issue in more detail than has been done previously.

6.2 Saha International's Analysis

The Electricity Commission asked Saha International to advise on the appropriate discount rate to use in the GIT. Saha International's report noted in its first paragraph that:

> *"The Commission has expressed a preference for a discount rate set equal to Transpower's regulated weighted average cost of capital …"*

and went on to say:

> *"The advice in this paper is primarily intended to initiate and inform discussion within the Commission on the appropriateness of using the Transpower WACC or one or more private sector rates as the discount rate for the GIT. It also considers the appropriateness of using a 'public' discount rate based on social time preferences, or perhaps some weighted average discount rate that recognizes both social and private time preferences."*[31]

Saha International's conclusions were:

> *"We suggest that the Commission derive a weighted average discount rate (some weighting of the social rate of time preference and the social opportunity cost). Further study is required, but it is reasonable to adopt the position that the Transpower WACC is a good approximation of such a rate given Transpower's numerous roles in the electricity sector as set out in its Statement of Corporate intent."*[32]

Saha International core chain of logic was:

1. The GIT is a form of national cost benefit analysis
2. For a national cost-benefit analysis, the appropriate discount rate is some weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital
3. Transpower's WACC is a reasonable proxy for the weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital.[33]

We agree with the first premise, that the GIT is a form of national cost benefit analysis. However the second and third steps in Saha International's chain of logic are wrong. As we explain below.

6.2.1 The Social Discount Rate is not a weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital

Saha International asserts that, for a national cost-benefit analysis, the appropriate discount rate is some weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital. No academic references for its assertion are cited. However, it is fair to acknowledge that up to 15 years ago this was the widely accepted view.

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[31] Saha International Nov 2004 p.1

[32] Saha International Nov 2004 p.45

[33] Saha International Nov 2004. This reasoning is set out in a number of places, including p.9

Earlier models of the public sector discount rate

We refer to these earlier theories of public sector project finance as 'closed economy models' (summarised in Lind, 1982). In a closed economy model, the funds invested in public sector projects were regarded as likely to partly displace consumption and partly displace private investment; and the benefits were seen as likely to result partly in increased consumption and partly in further rounds of reinvestment in the private sector. The assumption was that changes in consumption should be valued at the social rate of time preference, while changes in investment should be valued at the social opportunity cost of capital.

The social opportunity cost of capital is higher than the social rate of time preference because firms have to pay tax.[34] This creates a 'tax wedge' as illustrated in Figure 4. Without taxes, the savings match investment at a volume of funds V_0 and a return of r_0. With taxes at a rate of 33 percent, however, the rate companies pay for funds is 50 percent above the rate savers receive. In this situation, the social rate of time preference (measured by the rate at which savers are willing to postpone consumption, as discussed in 4.1) is below the rate which firms need to earn on their investment.

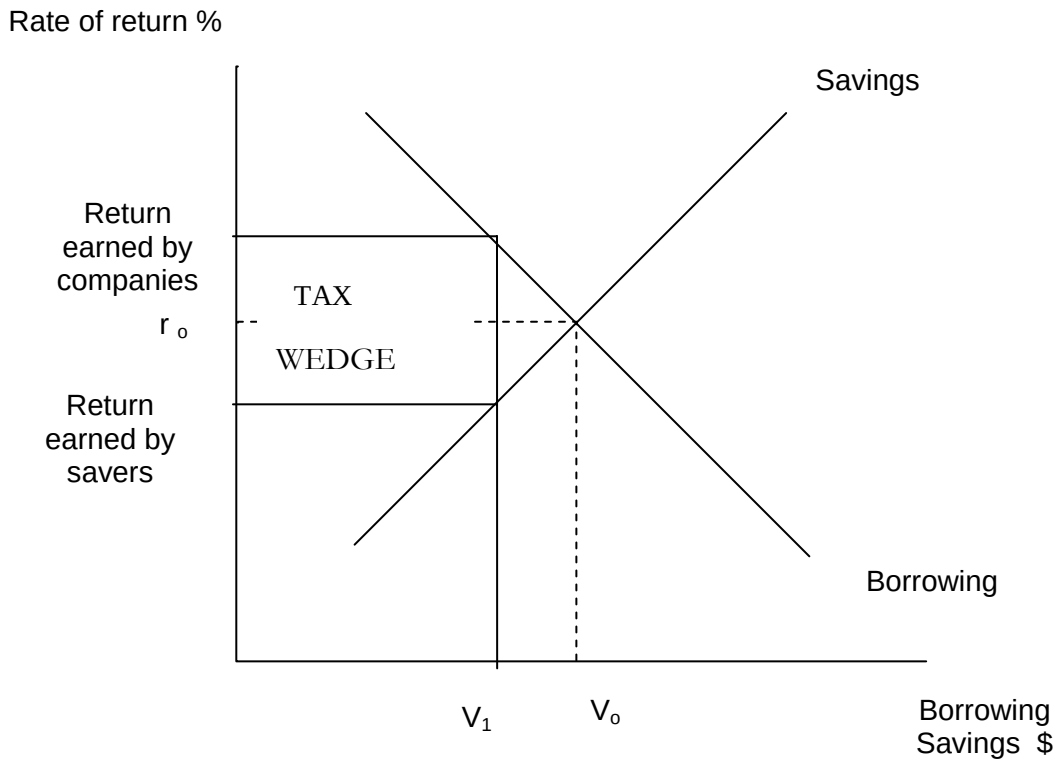
The return firms can earn on investment is referred to as the 'social opportunity cost of capital'. This is because if capital were somehow reallocated from private investment to another use the return which was lost—that is the opportunity cost of the forgone investment—would be the return on investment in the marginal project in the corporate sector.

In closed economy models, the appropriate social discount rate therefore depended on the precise mix of consumption and investment displaced by the costs of the public project, and on the mix of consumption and private reinvestment generated by the benefits. The difficulty that arose, however, was that it was not an easy matter to determine the mix of consumption and private investment displaced by the costs and derived from the benefits. The calculations became cumbersome and difficult to explain, and the results very sensitive to the assumptions (Lyon 1995).

Given the complexity of this process, a frequent practice was to discount the costs and benefits at some weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital, as advocated by Saha International. The difficulty persisted in determining the weightings to be applied. Implementation was therefore difficult and project specific.

[34] In some formulations the difference between the social rate of time preference and the social opportunity cost of capital is said to also take account of the fact that returns in the private sector include an allowance for risk-bearing. However, we prefer to assume that the same risk aversion which requires firms to earn higher returns on higher risk projects would also lead society as a whole to demand higher returns for bearing higher risk. That is why in this paper we model a social cost of bearing risk which is the same as the private cost of bearing risk (Section 4.2).

Figure 4: The Tax Wedge



Source: Castalia

Open economy models of the Social Discount Rate

In 1990, Robert Lind (then at Cornell University) published a paper that changed the thinking over the setting of the social discount rate. The change came in response to changes in macro-economic management whereby capital markets had become open and international. As a result of international financial market liberalization, capital became highly mobile between countries, creating a unified global market for saving and borrowing. In this global market an equilibrium world interest rate is continuously established.

The previous analysis of the social discount rate had been carried out on the assumption of a closed economy, in which government and private savings must equal government and private investment. The focus had been on the displacement or "crowding out" of private investment by the financing of public programmes.

Now, in a world of integrated capital markets, the link between total domestic savings and total domestic investment is broken. Small open economies like New Zealand essentially face an infinite supply of capital at the world interest rate (adjusted for currency and country risk).

From the perspective of the social discount rate, this means that the displacement of private capital is now recognised as being much less important than it was previously thought to be. As a result, the crowding out effect becomes much less important to the analysis of the social discount rate.

Lind's basic conclusion is that it is the consumers' marginal private rate of time preference that is relevant to setting the discount rate for government decision making in

a world of capital mobility and small open economies. Lind observed that the private rate of time preference for individuals who are savers is the market interest rate, after tax. For risk free investments, that interest rate will also be the government's borrowing rate, net of tax, which will in turn relate to world interest rates. This analysis led Lind to the conclusion that the government borrowing rate (post tax) is the best indication of the social rate of time preference. Lind's qualitative assessment has recently been formalised by Liqun Liu and colleagues.[35] This post tax formulation is the approach we adopted in Section 4.1.

In conclusion, Saha International recommends estimating the social discount rate as a weighted average of the social rate of time preference and the social opportunity cost of capital. This recommendation is based on public expenditure theories which are at least fifteen years out of date.

It used to be true that if the Government spent money it would push up interest rates, crowding out private investment. Therefore it made sense to take account of the lost return on investment—the social opportunity cost of capital—in evaluating government expenditure decisions. This reasoning simply does not apply to evaluation of the Auckland Upgrade under the GIT. It does not apply because in a small open economy like New Zealand the supply of capital for investment at the world interest rate is essentially infinite, and so investment in one project does not crowd out investment in other projects. Therefore there is no need to include a social opportunity cost of capital in the calculation, and hence the best estimate of the social rate of time preference is the post-tax return earned by savers.

6.2.2 Transpower's WACC is not a weighted average

Saha International assert that

> "*To the extent that Transpower continues to involve itself in addressing commercial and social objectives, the parameter values applying to Transpower provides an approximate proxy for the weighted average of the social rate of time preference and the private sector discount rate."*[36]

This is simply wrong. The WACC calculations referred to by Saha International were calculations designed to establish the commercial rate of return for a transmission business. All estimates of Transpower's WACC have been based on the CAPM, and all have used beta estimates derived from fully commercial companies. In other words, Transpower's pre-tax real WACC calculation was intended to reflect the full cost of bearing the commercial risk of investing in transmission assets.

The papers referred to by Saha International as the source of the WACC calculation—papers by the Transpower's Board and by Dr. Lally for the Commerce Commission—leave no doubt that the WACC is a fully commercial estimate. It can also be seen more directly by simply plugging the relevant betas estimates into a standard CAPM WACC formula. According to our simple calculations, with a beta of 0.4, Transpower's pre-tax

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[35] Liu, Liqun *The Multi-Period Cost-Benefit Rule with Mobile Capital and Distorted Labor* International Tax and Public Finance, 2005

Liu also generalises the theory to allow for the welfare cost to the economy of a marginal increase in tax by the government. This marginal welfare cost of taxation M, has a value of about 1.2. Normal public sector cost benefit analysis requires that the present value of benefits exceeds the present value of costs, written $B/C > 1$. The attraction of the Liu approach is that the generalised cost benefit rule accounting for the welfare cost of taxation is just $B/C > M$. The marginal welfare cost of taxation M, is generic, not project specific. As in the basic risk free theory, the discount rate in this formulation is the government's (post tax) borrowing rate. In the present setting, the marginal cost of taxation is not relevant as transmission projects are not tax funded.

[36] Saha International November 2004 p.47

real WACC would be 7.48 percent, while with a beta of 0.2 the pre-tax real WACC would be 5.3 percent.

It should be perfectly clear that a WACC estimate for Transpower derived from betas observed for fully commercial utilities is a fully commercial return. It is, in fact, the correct estimate of the Social Opportunity Cost of Capital. So even if Saha International was right in saying that the social discount rate should be a weighted average of the Social Rate of Time Preference and the Social Opportunity Cost of Capital, it follows that the discount rate must be below 7 percent. In fact, Saha International asserts that the Social Rate of Time Preference is between 3 and 5 percent.[37] A simple average of the mid-point of this estimate (4 percent) and 7 percent is 5.5 percent. In other words, were Saha International's approach to estimating the social discount rate correct (which it is not), their own numbers could not possibly support a discount rate as high as 7 percent.

6.2.3 Frontier Economics Analysis

Frontier Economics was not asked to consider the discount rate for the GIT in detail, but it did make some comments on the appropriate rate as part of a report to the Commission on all aspects of the GIT. Frontier Economics' conclusion was that

> *"For the sake of simplicity and competitive neutrality, the GIT should apply a single, private rate of return for investments in the electricity sector.*
>
> *Transpower's WACC is unlikely to be suitable for this purpose as it may not reflect the risk of investment in transmission to all relevant parties.*
>
> *By way of comparison, the Australian regulatory test is also based on a private discount rate. In Australia, recent central discount rates (pre-tax real) that have been applied under the regulatory test have been 8–9%, with sensitivities between 6 and 11%."*[38]

Frontier Economics' reasoning is confused or wrong in a number of places. For example, the report at one point states that investment in the project "involves the sacrifice of present resources which would otherwise be used for some combination of consumption, investment or foreign debt reduction"[39]. This may be true of a Government project, but it's not likely that paying down foreign debt would be an alternative use of funds for the Grid Upgrade. More importantly, this shows the continued influence of the old closed economy models which are simply not relevant now. As we discussed above, with an essentially infinite world supply of capital, there is no reason to think that an investment project like the Upgrade crowds out investment at all.

Essentially though, Frontier Economics' argument rests on an assertion that the discount rate should be the social opportunity cost of capital, since "the Part F objectives for the GIT require consideration of alternatives before a transmission project satisfies the test [so] it seems likely that in most cases, a regulated transmission project will have the primary impact of displacing private electricity investment."[40].

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[37] Saha International November 2004 p.42. The paper states that the social rate of time preference "is difficult to identify and normal assigned a range (3%-5%). The paper does not cite any evidence for this conclusion, and in fact Castalia's estimate of the real Social Rate of Time Preference is 1.25 percent (Section 4.1).

[38] Frontier Economics June 2004 pp.30 to 31.

[39] Frontier Economics June 2004 p.27.

[40] Frontier Economics June 2004 p.28.

It is hard to see what investment the Upgrade would displace. Unlike the situation in Australia (with which Frontier Economics is more familiar) there is no realistic prospect of unregulated transmission investment into Auckland, so Transpower's proposal clearly does not displace private transmission investment. In fact, even if there was a competing private Upgrade proposal, it would still be right from a social welfare point of view to compare Transpower's proposal to the private proposal using a social discount rate, not a private WACC. The investor in a private project would need to use its WACC in deciding whether to proceed with the investment, but the Electricity Commission should use the social discount rate in deciding whether to authorize the proposal under Part F.

If the Upgrade will not displace private transmission investment, perhaps Frontier Economics was thinking that it would displace private investment in generation. It is possible that building the Upgrade would lead to lower levels of investment in generation or demand side management in Auckland. However, the immediate practical point to be made is that the GIT is not being used to choose between the Upgrade and generation or demand side management. The Electricity Commission is using the discount rate solely to rank alternative projects, all of which would be undertaken by Transpower. The Commission recognized this, saying:

> *"The Commission believes the appropriate framework is primarily one of investment decision-making in a regulated environment"*[41]

It is quite clear that in the current use of the discount rate in the GIT there is no possibility of crowding out generation or demand-side investments. Its only use is to rank possible Transpower projects.

More fundamentally, generation and transmission are both substitutes and complements, so the Upgrade is likely to facilitate some private investment in generation, while deterring other investment in the short term. In the medium term, though, investment in generation will be driven by the growing demand for energy. Assuming our energy market continues to work well, enough generation will be built to meet demand. Transmission decisions will have little effect on the quantity of generation investment. However, transmission decisions will affect the location of that generation. For example, it may be cheaper to build a power station in New Plymouth than in Auckland, but if the station were built in Auckland a transmission upgrade might be deferred. Because of this interaction it would be desirable if the discount rate applied to the generation location decision where the same as the discount rate applied to the transmission decision. We assume that some such reasoning must have informed Frontier Economics' argument that the discount rate should be the private rate of return for investments in the electricity sector.

If Castalia's recommendations are followed, the social discount rate applied to transmission investments would be lower than the private investment rate applied to generation investments. This conclusion seems to follow from the decision to use a social cost benefit analysis for the GIT. Ultimately the problem is that taxation distorts investment decisions, so in a world with tax we will always face distortions. Examples in other sectors include the fact that road investment decisions are made based on a social discount rate, while investments in the location of businesses are made using private WACCs. Similarly, in education government investments are made at a social discount rate, while decisions by competing private schools may be made on the basis of WACC.

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[41] *Consultation Paper – Draft Grid Investment Test*, Electricity Commission 2004 p.10

It does not follow from these distortions on the border between social and private investment decision-making mean that using a corporate WACC as the social discount rate is the answer. In a world with tax, we need to use the principles of second best economics to find an approach which strikes the right balance between using the correct, undistorted number on the one hand, and compensating for distortions elsewhere in the economy on the other. In general, where there are two goods which are substitutes for each other, and one is subject to a distortionary tax while the other is not, it will be optimal to apply a 'shadow tax' factor in any cost benefit analysis. The shadow tax rate will be a factor of the degree of substitutability between the two goods, and the rate of tax applied to that good which is taxed. The intuition is clear; we want to reduce the losses caused by distorting choices between the two partial substitutes, while not introducing too much new distortion through the 'shadow tax'. The maths involved in getting this balance right however is rather complex.[42]

Fortunately in this case there is a simpler approach. The Commission has decided to develop a transmission alternatives methodology, and stated in its consultation on the GIT that

> *"The Commission believes alternatives should be assessed at the same discount rate as grid investment."*[43]

The transmission alternatives methodology, when developed, will likely allow generation location decisions to be paid for in the same way that transmission investments are paid for. In this way, a well specified transmission alternatives regime will allow the correct social discount rate to be used, while ensuring an efficient trade-off between investment in transmission and investment in transmission alternatives such as generation location decisions.

In light of this, there is no reason to use a social opportunity cost of capital or a private WACC in preference to a discount rate based on the social rate of time preference and an allowance for the social cost of risk bearing.

[42] See for example Boadway 2006 pp.15 to 17, following Harberger (1969).

[43] *Consultation Paper – Draft Grid Investment Test*, Electricity Commission 2004 p.10

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