OVERVIEW

Key points

- The discount rate is a critical parameter in cost-benefit analysis whenever costs and benefits differ in their distribution over time, especially when they occur over a long time period.
- Approaches to selecting real discount rates fall into two broad groups, both of which have given rise to a wide range of recommended rates:
  - a 'descriptive' approach based on the opportunity cost of drawing funds from the private sector; and
  - a 'prescriptive' approach that derives from ethical views about intergenerational equity.
- The arguments here support the descriptive approach and provide a starting point for the discount rate — the marginal return to private capital in Australia over the past four decades, which has averaged almost 9 per cent real.
- Market rates reflect the opportunity cost of investing in public projects, and there is no case for allocating resources to low return investments when higher returns are available. Using an artificially low discount rate for project evaluation can make future generations worse off. Ethical arguments for a low discount rate are more a reason to increase savings and investment.
- Government projects for which cost-benefit analysis can assist decision making cover a huge range: regulatory changes; infrastructure investments with significant gestation periods and long benefit streams, whose magnitudes are positively related to general economic conditions; and climate change policies with cost and benefit streams extending over centuries, but with high uncertainty.
- No single discount rate could meet the precise financing and risk characteristics of each project in this wide range of applications.
  - Taxes make a big difference between the before-tax 'investment rate' that investments earn and the after-tax 'consumption rate' that lenders receive, and a project's discount rate choice should ideally reflect the extent to which its financing reduces investment and consumption.
  - Government projects are not in general free of risk; some have expected net benefits inversely related to aggregate consumption, but many have expected net benefits positively correlated with aggregate consumption. Discount rates should embody an appropriate compensation for risk. The rate should be equal to the rate of return on private projects with similar levels of risk. The market price of risk is what people have to be paid to bear risk and reveals attitudes to risk even where markets are imperfect.
- The appropriate adjustments for taxes and risk cannot be precisely estimated — one reason why sensitivity testing is important. A base rate of 8 per cent, and testing over a range of 3 to 10 per cent is proposed.

Overview

Cost-benefit analysis is used to improve decision making by systematically comparing the social costs and benefits of government policies, with the emphasis on valuing them (to the extent possible) in monetary terms. It provides decision-makers with quantitative information about the policy's likely effects and encourages them to take account of all the positive and negative effects and the linkages between them. Quantifying the impact of government policies in a standard manner promotes comparability, the assessment of relative priorities, and consistent decision making.

Moreover, the process of trying to describe and measure costs and benefits is valuable in itself. By examining what determines the costs and benefits and how they are likely to vary, policy makers are encouraged to consider different approaches and determine the best way to achieve objectives. Identifying and measuring costs and benefits encourages close examination of the factors that influence them and assists in minimising costs and maximizing benefit, helping decision makers increase net benefits to society.[1]

Cost-benefit analysis can be used to analyse and strengthen a wide range of government choices, including whether to undertake an infrastructure project, provide a service, pass a regulation, produce a public good, change a social welfare programme or adjust a tax.

Most government policies or projects give rise to a stream of costs and benefits over time. A key element of the cost-benefit analysis framework is the use of a discount rate to compare costs and benefits received at different points in time. Yet there is little agreement about the appropriate discount rate, with cost-benefit guides, academics and textbooks giving conflicting advice. A wide range of discount rates has been recommended, with the average and the bottom of that range falling over recent years.

The choice of discount rate can make a significant difference to whether the present value of a project is positive, and to the relative desirability of alternative projects, especially when costs and benefits accrue at different times and over long periods.

[1] See Australian Government (2007, p. 115) for the benefits of using cost-benefit analysis.

As table 1.1 illustrates, the higher the discount rate, the smaller the present value of future costs and benefits. The further in the future the payments are received, the greater the effect of the discount rate. A high discount rate favours projects with benefits that accrue early.

Table 1 **How present value of $1000 varies with when it is received and the discount rate**

Discount rate	*Years in the future*		
Per cent	10	50	100
1	$910	$608	$370
3	$744	$228	$52
8	$463	$21	$0.45
10	$386	$9	$0.07

Source: Author's calculations. The present value of $1000 received n years in the future with a discount rate *r* is $1000/(1+r)^n.

Aims

This paper is about discount rate choice: how to discount estimated cost and benefit flows. It is not about whether cost-benefit analysis should be used, or how well costs and benefits can be quantified. These are separate debates.

Putting a dollar value on a project's costs and benefits may be a difficult task — it is not easy to estimate the benefits flowing from a public good, environmental improvements or safety measures that that save lives. There may be considerable uncertainty about predicted impacts and their appropriate monetary valuation. But that is a reason for conducting sensitivity analysis with the disputed variables and improving the estimates, and does not affect the case for discounting.[2] Defects in the measurement of costs and benefits should be directly addressed and do not justify adjusting the discount rate.

2 Sensitivity analysis provides information about how changes in values assigned to different variables will affect the overall costs and benefits of the policy proposal. It shows how sensitive predicted net benefits are to different values of uncertain variables and to changes in assumptions. It tests whether the uncertainty over the value of certain variables matters, and identifies critical assumptions. See Australian Government (2007, p. 122-23) for more on sensitivity analysis.

Why discount?

The case for discounting future costs and benefits arises from opportunity costs. The cost of investing a dollar in a project is what it would have produced in its alternative use. Because invested capital is productive, an extra dollar invested today in the private sector will (on average) grow to more than a dollar tomorrow, a fact reflected in positive market interest rates. Tying up a dollar today in any project requires a return of more than a dollar tomorrow to ensure the project covers its costs and produces benefits greater than from leaving the money in the private sector.

Dollars are valuable for what they can buy. Inflation is one reason a dollar in the future is worth less than a dollar now. The usual approach in cost benefit analysis is simply to express all costs and benefits in real or constant-price dollars, which avoids having to estimate the future course of inflation. But that requires the analyst to convert past nominal flows into real dollars and to specify a real discount rate.[3]

Expressing cost and benefit estimates in terms of constant purchasing power and using a real discount rate does not mean the prices of individual products and factors are fixed at current prices. Anticipated changes in the relative price of important outputs and inputs into the project (such as possibly rising relative values of environmental benefits), as distinct from general price level changes, should be reflected in the estimates of future costs and benefits.[4] The discount rate should be consistent with the dollar flows being discounted. If costs and benefits are measured in nominal (or current) dollars, they should be discounted with a nominal discount rate; costs and benefits measured in real terms (that is, adjusted for inflation), should be discounted with a real discount rate.

Different approaches to the discount rate

Academics, cost benefit guides and textbooks give widely conflicting advice on discount rate selection, with recommended rates varying from 1 to 15 per cent, with the rates recommended in most developed economies trending down over recent decades. The two major schools of thought are the prescriptive and descriptive approaches to discount rate selection (chapter 2).

The prescriptive or normative approach directly specifies a discount rate influenced by ethical principles (sometimes literally deriving from the assessments of

[3] See appendix A, section A.2.

[4] Harberger (1969, footnote 16, p. 122).

philosophers). It mixes efficiency and equity considerations, and is frequently advocated when projects affect future generations. The prescriptive approach gives a wide range of suggested discount rates, reflecting different value judgements that cannot be resolved objectively.

The descriptive approach to the social discount rate is based on the opportunity cost of capital used in the project: what benefits to society the funds would return if left in the private sector. It is based on the efficiency criterion.

Chapter 2 makes the case that project choice should be based on discounting with an efficiency-based social discount rate, even for projects implying benefits or costs for future generations. But focusing on an efficiency-based social discount rate still leaves plenty of room for disagreement. Complications include the effects of capital taxes, capital market imperfections and uncertainty. Theory about ideal adjustments for these factors is far ahead of our empirical knowledge. Selection of a social discount rate depends on parameters that can only be imperfectly estimated, and reasonable people can make different judgments about them. Recommendations about the social discount rate should be practical and account for this imperfect empirical knowledge.

The discount rate and market benchmarks

Chapter 3 explores the utility of market benchmarks for deriving practical estimates of the discount rate applicable to various projects.

Capital taxes drive a substantial wedge between the before-tax investment return and the after-tax consumption rate of interest, making it important to distinguish between the project's financing impacts on investment and consumption.

If government investment comes at the expense of private investment, the cost to the economy is measured by the social returns that would have been generated by that investment. This has been variously labelled the investment rate of interest, the producer rate of interest, the marginal rate of return to investment or capital, the marginal efficiency or product of capital, or the social opportunity cost of capital.

On the other hand, a cost benefit analysis of a project values the stream of costs and benefits that accrue to consumers. The consumption rate of interest determines the consumer's valuation of current relative to future consumption — the consumer's marginal rate of time preference. The consumption rate of interest is usually measured by the after–tax real rate of return on savings — the supply price of savings. The discount rate that reflects the opportunity cost of capital is a weighted average of the consumption rate, the investment rate, and the marginal cost of

foreign funds with the weights being the proportion of project costs sourced from consumption, from investment and from foreign funds. In practice, there is little information about the weighting of each source, or even the precise cost of each source. Nevertheless, to use any particular social discount rate is to implicitly assume something about these variables, and it is better to make the assumptions explicit. What is needed is a reasonable rule of thumb. For reasons elaborated in Chapter 3, there is a reasonable presumption that the weighted average rate will lie close to the before-tax investment rate.

The risk free before tax rate of return in Australia is around 4 per cent, and so the risk free social discount rate is significantly greater than rates usually derived from the Ramsey equation approach (chapter 3) – which produces a consumption rate (often around 1 to 2 per cent).

Estimates of the rates of return on capital in the market sector in Australia are also presented in Chapter 3. A reasonable estimate of the marginal rate of return to capital (or the opportunity cost of forgone private investment) is 9 per cent real. This market return includes a risk premium that compensates investors for the risk they bear.

Estimates of uncertain future costs and benefits should be a risk-weighted average (or 'expected value)' of all possible outcomes — including possible disasters and windfalls – accounting for what could happen, not just what should happen. The most practical way to account for the costs of project risk is to discount these expected values with a discount rate that includes a risk premium, whether discounting costs or benefits. Some have argued that government projects should be discounted using a risk-free rate. However there is an element of risk — aggregate risk or irreducible social risk — that cannot be diversified, even by the government. It is caused by shocks such as recessions and variations in the market return, which affect consumption. This undiversifiable aggregate risk should be reflected in a risk premium in the discount rate for policies or projects whose net benefits are likely to be positively correlated with the performance of the overall economy. Governments should only discount with the risk free return if either:

- the project is risk free, or
- the market is able to spread all the risk associated with the project, or
- the government spreads all risk so that the project does not impose risk on beneficiaries and taxpayers, or
- the expected values of cost and benefit flows have been converted into 'certainty equivalents'.

Taxpayers and program beneficiaries are essentially equity holders in the government project. When a risky stream of payments from a government project accrues to individuals, they incur the costs of risk. It is their valuation of the stream that is relevant. The market price of risk is what people have to be paid to bear risk and reveals attitudes to risk even where markets are imperfect.

Even if the government can spread risks the market cannot, if the government has the option of investing in the private sector, say through a sovereign wealth fund, the private market return is the opportunity cost of investing public funds and is the appropriate discount rate for public investment projects.

A few policy decisions have potentially significant impacts many generations hence. Climate change policies are a topical example. Some arguments point to lowering the rate used to discount the distant future, while others suggest raising the rate. For example, uncertainty about the long term path of interest rates suggests that, on the one hand, we should use a lower real interest rate to discount costs and benefits received further in the future (the yield curve for real interest rates slopes down). Moreover, the appropriate risk premium may fall with the length of project. On the other hand, the option value of delay may in some cases favour a higher rate.[5] Uncertainty about how to adjust the rate makes it particularly important for sensitivity testing a range of discount rates for analysis of very long-lived projects or policy choices.[6]

Practical implications

The arguments developed in this paper suggest using a discount rate based on the marginal rate of return on capital, such as the national accounts measure of the before-all-tax real rate of return on private capital. This has averaged 8.9 per cent over long time periods, and is more stable than share market returns.

The marginal rate of return to capital should be adjusted to reflect the impact of tax distortions and foreign borrowing. That reduces the rate of return by around 1 percentage point to around 8 per cent.

The resulting weighted average market rate includes the market risk premium. It is the appropriate discount rate for a government project which has the same risk as the average private sector investment. The rate reflects the opportunity cost — the

[5] Chapter 3, section 3.6 and Appendix I, discusses further how the value of delaying a project may alter the appropriate discount rate to use in evaluating it.

[6] PC (2008) develops this example in the context of the Stern Review of the economics of climate change.

funds used in the government project would have produced this return if left in the private sector, with no greater risk. The presumption in favour of the market risk premium can be varied if there is a clear argument to the contrary, such as evidence that the amount of market risk in project flows is likely to be low. For example, some projects may offer insurance benefits whose value is inversely correlated with economic conditions.

In the absence of further information, 8 per cent is a reasonable default discount rate, but there is still considerable imprecision in empirical estimates. The weights and returns to use in the weighted average discount rate, and the appropriate risk premium, are not clear. As with any uncertain variable, sensitivity analysis provides valuable insights.

Sensitivity testing using real rates of 3, 8 and 10 per cent is proposed in this paper — representing the weighted average riskless rate of return, the weighted average rate of return and a rate of return for a riskier asset or that reflects the marginal productivity of capital during the 2000s. (The suggested dispersion around 8 per cent is not symmetrical, because there are fewer arguments for much higher rates than for much lower rates.)

If the sensitivity analysis reveals that the choice of discount rate changes the sign of the project's net present value or changes the ranking of alternatives, then more consideration should be given to the choice of an appropriate rate — such as the risk characteristics of the proposal (for example, the extent of fixed costs and how costs and benefits vary with the state of the economy). Project flows that are more sensitive to market returns and other factors should have a higher discount rate, while projects that are less sensitive should have a lower one.

Further sensitivity testing can be used to help determine the appropriate rate, such as calculating the project rate of return (the rate at which the net present value is zero). If the rate of return is above plausible discount rates, then the project is likely to improve economic efficiency, an important consideration that should inform the decision about whether to adopt the project.