CHAPTER 9: DISCOUNTING

Overview

Discounting can be a pretty dry subject, but scratch the surface and there are a lot of deep questions that underlie discussions about the appropriate discount rate in policy analysis. The theory of discounting draws on:

- Economics: How do we maximize social welfare over time?
- Accounting: How do we assess the profitability of a project?
- Philosophy: What, if anything, does the current generation owe future generations? Should government impose patience?

Businesses discount future revenue streams to take account of the opportunity cost of investment funds. For example, a bank can invest $500,000 in opening up a new branch, or invest the money in the stock market with an 8% expected return. If the bank opens up a new branch, it can expect profits of $10,000 for the first three years, and $20,000 every year thereafter. So is opening the branch profitable, assuming the risk is the same as in the stock market? Businesses use discounting to answer the question: Are we investing funds in a way that maximizes profits?

There are several justifications for discounting in policy analyses.

Rationale 1: If we want government decisions to **maximize social welfare**, then decisions should take account of public preferences. Government should act on our behalf. We believe there is a societal preference for current consumption over future consumption. You can think of the discount rate as a price for shifting consumption across time.

Rationale 2: If public **spending displaces $1 of consumption, the** cost is $1. If public spending displaces private investment, the cost is $1 plus whatever return the investment would earn. If the government finances spending via borrowing, it will increase the demand for loans, which will increase the interest rate (the price of borrowing). Many large local and state projects are financed via bonds, which reduces the pool of funds available for private investment.

Rationale 3: If we don't discount, we might get **weird, counterintuitive results**. How do you value an infinite stream of returns? For example, suppose government could spend $10 billion today for a project that would yield $1 every year thereafter. Is the project worthwhile? Not if the discount rate is positive.

Mechanics of discounting

The present value of X dollars received at time t is

$$PV(X_t) = \frac{X}{(1+d)^t}$$

In most cases it won't matter whether you assume that interest is compounded at the beginning or end of the period as long as you are consistent about it.

In some cases we want to know the present value of an infinite sum (for example, the present value of $20,000 received every year from now until eternity). There is a neat little trick:

$$\frac{X}{(1+d)^1}+\frac{X}{(1+d)^2}+\frac{X}{(1+d)^3}+\ldots+\frac{X}{(1+d)^\infty}=\frac{X}{d}.$$

Sometimes authors refer to the discount rate. The discount rate is d, a number between 0 and 1. You may come across a reference to a "discount factor." The discount factor is

$$\frac{1}{(1+d)}.$$

Choosing a discount rate

Businesses should select a discount rate that reflects the return on an investment with a similar level of risk. (For example, returns on the stocks of firms in the same industry).

The choice is less clear for government. One approach is to set the discount rate to the social rate of time preference. Another is to peg the discount rate to the rate of return on displaced funds (i.e., investments that would have occurred if taxes were lower).

Since the social rate of time preference is not directly observable, there is a robust discussion about how to measure it.

Some researchers use surveys of the form, "Would you rather have 100 today or $X tomorrow?" Of course surveys are artificial. Respondents don't have to face the consequences of their responses.

The preferred approach is to use market interest rates. Market interest rates are based on real world behavior. There are many different interest rates in the market at one time (e.g., the rate on savings, 30 year mortgages, business loans). The preferred approach is to use the interest rate on short-term treasury bonds because they are riskless. Some experts advocate reducing this rate by the tax rate on savers (about 30%) and also by inflation expectations.

Market interest rates reflect the preferences of those who save. Many people have no savings. The low savings rate and the widespread use of high-interest debt (e.g., payday loans) suggests the social discount rate is much higher than the conventional estimate of 3%. Should government respect these preferences? Or should government act paternalistically and use a discount rate that is lower than the average discount rate in the population? Put another way, should government try to correct our tendency to put too much emphasis on the present at the expense of the future?

Recommendations for discount rates

The US Panel on Cost-Effectiveness in Health and Medicine[1] recommends using a base case discount rate of 3% and conducting a sensitivity analysis with rates in the range of 0% to 7%.

The US Office of Management and Budget[2] recommends costs be discounted by 3%, reflecting the social rate of time preference, and 7%, reflecting the opportunity cost of capital (i.e., the rate of return on displaced funds).

Distributional issues

In most applications the discount rate for benefits and costs is the same. However, they need not be. If the group that is taxed differs from the group that receives the benefits from the project, it is permissible to use different discount rates. In practice, analysts almost always use the same rate to discount costs and benefits.

How should we value the welfare of future generations? Even with a relatively low discount rate, like 3%, what happens in 200 years doesn't really matter in present value terms.

$$\frac{1}{(1.03)^{200}} < 0.01$$

The choice of a discount rate has a strong influence on the outcomes of environmental policy analyses because the benefits often occur many years into the future.

Discounting health

Evaluations of programs that improve health require us to discount benefits, which are sometimes stated in terms of health, and costs. Should costs and benefits be discounted at the same rate? There are several justifications. First, for an individual, health is not tradable. You can't save health. (But society at large can trade off health today for health tomorrow.)

Second, behavior (e.g. smoking) implies that many people have very high discount rates for health. Third, the value of good health is improving. Using a low discount rate is a way to capture the fact that the value of a given unit of health changes over time. Suppose the value of health is increasing at 2% a year, so 1 QALY today is worth 1.02 QALYs in one year. Also suppose the social discount rate is 3%. Then one method of discounting health while capturing the fact that the benefit of good health is increasing is to discount at 1% (= 3% - 2%).

Britain's National Institute for Clinical Effectiveness used to recommend discounting costs at 6% and benefits at 1.5%. The current recommendation is to discount both at 3.5%.

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[1] Weinstein et al. Recommendations of the Panel on Cost-Effectiveness in Health and Medicine. *Journal of the American Medical Association* 1996;276(15);1253-1258.
[2]Office of Management and Budget. Circular A-4. September 17, 2003.

Here is what the US Panel on Cost-Effectiveness in Health and Medicine had to say on the subject.

> [Discount] rates reflect people's preference for having money and material goods sooner rather than later. Similarly, people value health outcomes that occur in different time periods differently. In CEA, time preference for resources is reflected by discounting future costs to present value. Discounting the value of future expenditures requires that health effects experienced in the future also be discounted at the same rate. This conclusion is based on the observation that people have opportunities to exchange money for health, and vice versa, throughout their lives. Failure to discount health effects will lead to inconsistent choices over time; for example, it will appear that delaying investments will always result in a program's becoming more cost-effective. For this reason and based on other evidence and considerations outlined in its full report, [3] the panel recommends that costs and health outcomes occurring during different time periods should be discounted to their present value and that they should be discounted at the same rate.

Discounting at different rates can lead to odd conclusions

Suppose a program costs $100,000 and delivers benefits of 2 QALYs. Is it better to perform the project now or in 100 years?

The cost effectiveness ratio if the project is undertaken today is:

$$\frac{\$100{,}000}{2} = \$50{,}000$$

The cost effectiveness ratio if the project is undertaken in 100 years and costs and benefits are discounted at 3% is:

$$\frac{\dfrac{\$100{,}000}{(1.03)^{100}}}{\dfrac{2}{(1.03)^{100}}} = \frac{\$100{,}000}{2} = \$50{,}000\,.$$

The cost effectiveness ratio if the project is undertaken in 100 years and costs are discounted at 3% and benefits at 1% is:

$$\frac{\dfrac{\$100{,}000}{(1.03)^{100}}}{\dfrac{2}{(1.01)^{100}}} = \$7{,}036.$$

Postponing the project until 500 years is associated with a cost-effectiveness ratio of $2.70 with unequal discount rates. This just doesn't make sense.

Amortization

If you want to describe the yearly cost of a multi-year program, but some of the costs are incurred only once, you might use amortization to "annualize" the cost. For example, what is the annual cost to a health care facility of building a new outpatient clinic that costs $25,000 up-front but will last 20 years? You might ask the question: Suppose we took out a 20 year loan for $25,000. How much would we have to repay annually?

$$\$25{,}000 = \frac{X}{(1+d)^1} + \frac{X}{(1+d)^2} + \frac{X}{(1+d)^3} + \ldots + \frac{X}{(1+d)^{20}}$$

If d = 0.03, X is $1,680. I calculated this using the formula "=PMT(0.03,20,25000)" in Excel. This figure is quite a bit higher than what you'd get if you simply divided $25,000 by 20: $1,250.

The calculation described above is sometimes referred to as "amortizing" the cost. Another way to think about this calculation is that $1,680 is the rental price of a good.

Discounting ≠ Adjusting for inflation.

Both adjusting for inflation and discounting involve adjusting sums of money over time. They are easy to confuse. But conceptually, they are very different.

Inflation adjustment is "backward-looking." We are restating historical cost/price figures in today's dollars. The key input is the inflation rate or a price index.

Discounting is "forward-looking." We discount future sums to account for the preference for current over future consumption. The key input is the discount rate.

Market interest rates account for 1) rate of time preference, 2) inflation expectations, 3) the riskiness of a project. Forget #3 for a minute. The market interest rate is:

$$r = (1+d)(1+i)$$

Where r is the interest rate, d is the discount rate, and i is the inflation rate. We want to use d when discounting, not r.