CHAPTER 10: THE SOCIAL DISCOUNT RATE

Purpose: This chapter deals with the theoretical issues pertaining to the selection of an appropriate real social discount rate (SDR). When evaluating government policies or projects, analysts must decide on the appropriate weights to apply to policy impacts that occur in different years. Given these weights, denoted by $w_t$, and estimates of the real annual net social benefits, $NSB_t$, the estimated net present value (NPV) of a project is given by:

$$NPV = \sum_{t=0}^{\infty} w_t NSB_t$$  \hspace{1cm} (10.1)

Selection of the appropriate SDR is equivalent to deciding on the appropriate set of weights to use in equation (10.1). Sometimes the weights are referred to as social discount factors.

Scholars have proposed two primary methods to determine the SDR: the social opportunity cost of capital (SOC) method and the social time preference (STP) method; this chapter describes both methods and explains the differences between them. The SOC method relies on market-based estimates and consequently is sometimes referred to as the descriptive approach. The STP method derives the parameters of an optimal growth model and obtains shadow prices for their values; consequently, it is sometimes referred to as the prescriptive approach.

DOES THE CHOICE OF DISCOUNT RATE MATTER?

Yes – choice of the rate can affect policy choices. Generally, low discount rates favor projects with the highest total benefits, while high SDRs rates favor projects where the benefits are front-end loaded.

WHEN THERE IS NO DOUBT ABOUT THE APPROPRIATE SOCIAL DISCOUNT RATE

An Individual’s Marginal Rate of Time Preference (MTRP)

An individual’s MRTP is the proportion of additional consumption that an individual requires in order to be willing to postpone (a small amount of) consumption for one year.

Equality of MRTPs and Market Rates in Perfect Markets

In a perfectly competitive capital market, an individual’s MRTP equals the market interest rate, $i$, as shown in Figure 10.1. In this two-period model, an individual may consume her entire budget (T) in the first period, she may invest it all in the first period and consume $T(1 + i)$ in the second period, or she may consume at any intermediate point represented by the budget constraint in Figure 10.1, which has a slope of $-(1 + i)$. Consumption is maximized at the point at which her indifference curve is tangential to her budget constraint, i.e. at point A. At point A, the slope of the indifference curve is $-(1+p)$, the marginal rate of substitution (MRS) is $1+p$, and the MRTP is $p$. Consequently, $i = p$. Note that as current consumption increases, MRS and MRTP decrease.
Equality of the Social Rate of Time Preference and the Return on Investment in Perfect Markets

We now extend the analysis to a two-period model that incorporates production. It applies to a hypothetical country that does not trade with any other country, that is, it is a closed economy. Moreover, as before, our analysis simplifies things by assuming there are no market failures or taxes, and that there are no transaction costs associated with borrowing and lending.

The optimal point is at X in Figure 10.2. At X, the slope of the social indifference curve, \(-1 + p_x\), equals the slope of the consumption possibility frontier, \(-1 + r_x\). Consequently, the marginal social rate of time preference, \(p_x\), equals \(r_x\), the marginal rate of return on investment (ROI). Furthermore, at point X these rates would also equal the economy-wide market interest rate, \(i\). Finally, at X, all individuals have the same MRTP because, if their MRTP > \(i\), they would borrow at \(i\) and consume more in the current period until their MRTP = \(i\) and, if MRTP < \(i\), they would postpone consumption by saving until their MRTP = \(i\). Since everyone’s MRTP equals \(i\), it would be the obvious choice for the SDR.

Complications in Real Economies

An actual economy (with externalities, taxes and transaction costs) would not operate at the optimal point X, but at a point such as Z. Here, society would under invest and \(r_z > p_z\). Furthermore, because different people face different tax rates, risk and costs, numerous values exist for both the MRTPs and the ROI. Thus, there is no obvious choice for the SDR.

THE SOCIAL OPPORTUNITY COST OF CAPITAL (SOC) METHOD

The social opportunity cost of capital (SOC) method builds on influential work by Arnold Harberger. Harberger analyzed a closed domestic market for investment and savings, such as the one shown in Figure 10.3. He assumed that any new government project would be funded by domestic government borrowing which would raise the interest rate and result in a fall in private investment and an increase in savings. Harberger argues that the social discount rate should reflect the social opportunity cost of capital, which can be obtained by weighting the marginal return on investment (ROI) and the after-tax marginal return on savings (CRI) by the size of the relative contributions that investment and consumption would make toward funding the project. That is, he suggests that the SDR should be computed using the social opportunity cost of capital, denoted SOC:

\[
SOC = a*CRI + b*ROI
\]  
\[(10.5)\]

where, \(a = \Delta C/(\Delta I + \Delta C)\), \(b = \Delta I/(\Delta I + \Delta C)\), and \(a + b = 1\).

Subsequently, Lind and others argue that foreign borrowing is another potential source of funding. If so, the SOC would be given by:

\[
SOC = a*CRI + b*ROI + c*CFF
\]  
\[(10.6)\]
where, a, b, and c are the proportion of funds from consumption, investment and foreign borrowing, and CFF is the marginal cost of foreign funds.

There are a number of special cases of the SOC method.

**Using the Marginal Rate of Return on Private Investment (ROI)**

Some economists and policy makers have argued that the social opportunity cost of capital equals ROI, which is equivalent to setting b = 1 in equations (10.6) and (10.7). This approach would be appropriate if all government funding came at the expense of private sector investment, not through taxes (which affect consumption) or borrowing from foreigners. Because this condition is unlikely to hold, we do not recommend discounting at the ROI.

**Using the Government’s Borrowing Rate (TBR)**

Proponents of this method usually justify it on the grounds that the government’s borrowing rate is appropriate because it is what a government pays to finance a project. However, Anthony Boardman and Mark Hellowell point out that while this rate might be appropriate if the goal were to maximize the present value of net revenue (cash flow) to the government (or its Treasury), it would not to maximize allocative efficiency.

**Using the Government’s Risk-Free Rate Adjusted for the Project’s Systematic Risk (ROI(SRP))**

Again, this method might be appropriate if the goal were to maximize the present value of net revenue (cash flow) to the government (or it’s Treasury), but not to maximize allocative efficiency.

**Using the Marginal Social Rate of Time Preference Method (p	extsubscript{z})**

Many analysts hold that the SDR should be thought of as the rate at which individuals in society are willing to postpone a small amount of current consumption in exchange for additional future consumption (and vice versa). In principle, p	extsubscript{z} represents this rate. Consequently, many believe that the SDR should equal p	extsubscript{z}. Thus, p	extsubscript{z} may be thought of as an estimate of the STP. However, if a government project is financed entirely by domestic taxes and if taxes reduce consumption, but not investment, then it would be appropriate to set a = 0 and b = 1 in equation (10.6), yielding an SDR equal to p	extsubscript{z}. In this way p	extsubscript{z} can also be thought about as a special case of SOC.

**Estimation and Numerical Values for the SOC.**

Estimation of the SOC requires estimates of the parameters in equation (10.6). One way to estimate the ROI is based on the assumption that a firm will invest in a new project only if the after-tax ROI on that investment is greater than the firm’s weighted average cost of capital. Using this approach, evidence suggests that, the real marginal ROI for the United States has averaged about 6.8 percent from 1947–2010. A direct estimate of the marginal CRI is provided by the real, expected after-tax return to holding government bonds or equivalent savings vehicles, such as savings deposits. Using the average real, expected return to 10-year US
Treasury bonds from 1953 to 2011 and an individual tax rate on savings of 30 percent implies that the real CRI is about 1.2 percent. One way to estimate the real marginal cost of foreign borrowing is to use the real, expected pre-tax return on 10-year US Treasury bonds. This return averaged 2.6 percent from 1953 to 2011. David Burgess and Richard Zerbe propose that $a = .10$, $b = .54$ and $c = .36$. Using these weights and the above estimates of CRI, ROI and CFF equal to 1.2, 6.8 and 2.6 percent, respectively, lead to an estimate of the SOC for the United States equal to 4.7 percent, or approximately 5 percent in round numbers.

**Criticisms of the SOC Method and the Resultant SDR Estimate**

There are several criticisms of both the use of SOC and of its estimation, suggesting that 5 percent is an upper limit of the SDR.

1) The weights might be incorrect. Specifically, the weight on ROI, which has the largest value among the three components, may be too high. The above estimate of $b$ assumes that funds come primarily at the expense of private-sector investment. However, it is more likely that government projects are tax financed, not debt financed, and the majority of taxes are obtained from consumers.

2) Different projects may be funded in different ways, resulting in different values.

3) The ROI estimate might be an estimate of the average ROI, not the marginal ROI.

4) Estimates of the ROI incorporate a risk premium. Therefore, if benefits and costs are measured in certainty equivalents, as recommended by the text, then using private sector rates would result in “double counting,” i.e. it would account for risk in two ways.

3) A project may be partially financed by foreigners at a lower rate than 4.5 percent.

4) Private sector returns may be pushed upward by distortions caused by negative externalities and market prices that exceed marginal costs.

5) Private sector returns may be biased upward due to market failures.

6) It is hard to know how to estimate the CRI because different people face different rates depending on whether they are borrowing or saving. Some people are simultaneously borrowing and saving.

7) Some people make inconsistent choices.

8) Current, market rates do not reflect the preferences of future generations.

**THE SOCIAL TIME PREFERENCE (STP) METHOD**

Many years ago, Frank Ramsey suggested an approach for determining the SDR that does not rely on market rates of interest. He proposed a model with infinite periods in which society (or a single representative individual) attempts to maximize a social welfare function that reflects the values society places on per capita consumption over time. This model reflects the preferences of future generations as well as those currently alive. Through investment, consumption increases over time. Policy makers choose the amount of public investment in order to maximize the well-being of society now and in the future.

A number of economists have demonstrated that maximization of such a social welfare function implies that, on the optimal growth path, society’s *marginal rate of time preference*, STP, would equal the sum of two components: one that reflects the reality of impatience and the other that reflects society’s preference for smoothing consumption over time:
\[
\text{STP} = \rho + ge \tag{10.8}
\]

where, \(g\) is the percentage change in per capita consumption (i.e. consumption growth) and \(\varepsilon\) is the absolute value of the elasticity of the marginal utility of consumption with respect to changes in consumption; and \(\rho, g, \varepsilon \geq 0\). This equation is known as the Ramsey formula (for computing the SDR). In principle, \(\rho, g\) or \(\varepsilon\) could vary over time periods. However, we assume that they are constant and, therefore, the STP is constant, at least within a generation.

The model assumes that because of economic growth, the consumption of society will grow over time. However, because of the declining marginal utility of consumption, consumption should be made more equal than it otherwise would be. This adjustment should be proportional to the product of the per capita growth rate and an elasticity, \(\varepsilon\), that measures how fast the social marginal utility of consumption falls as per capita consumption rises. For example, if \(\varepsilon = 1\), a 10 percent reduction in consumption today from (say) $40,000 to $36,000 would be viewed as an acceptable trade-off for a 10 percent increase in consumption (say) from $80,000 to $88,000 at some future point.

Estimation of, and Numerical Values for, the STP.

The value of the STP depends on the value of three parameters: \(\rho, g,\) and \(\varepsilon\). There has been considerable debate about the value of \(\rho\) since Ramsey’s original article. Kenneth Arrow suggests a figure of around 1.0 percent for \(\rho\). The future growth rate of per capita consumption, \(g\), can be derived by estimating past growth rates and making assumptions about whether the future growth rate will be similar or not. Although the annual US growth rate averaged approximately 2.2 percent over 1947–2009, we think \(g\) will equal about 1.9 percent in the future. One way to infer \(\varepsilon\) is from the progressivity built into the federal income tax schedule. For the U.S., this estimate is about 1.35, which seems reasonable to us. With \(g = 1.9\) percent, \(\varepsilon = 1.35\), and \(\rho = 1.0\) percent, our best estimate of the STP (for developed countries) is 3.5 percent. It would be reasonable to conduct sensitivity analysis at 2.3 and 5.5 percent.

Special Case of the STP: The Shadow Price of Capital (SPC)

A potential problem with using the STP as the social discount rate is that resources invested in the private sector generally earn a higher return than the STP. If a government used a lower discount rate than the private sector, then it would undertake projects that the private sector would not undertake and it would grow undesirably large. A public-sector project should be undertaken if its benefits would exceed the opportunity cost of the resources; otherwise, it should not. To ensure that society would be better off through government projects, changes in private-sector investment flows associated with a particular project should be converted into consumption equivalents by weighting them by a parameter, called the shadow price of capital, \(SPC\), prior to discounting.

Suppose that \(f\) is the fraction of the return on an investment that is reinvested each period. Then, the SPC is given by:
Numerical Values of the SPC

Computation of the SPC requires values for STP, ROI and \( f \). We have already suggested that STP equals 3.5 percent and ROI equals 6.8 percent. The gross investment rate (the ratio of real gross fixed investment to real GDP) provides a rough estimate of \( f \), the fraction of the gross return that is reinvested. Using data from the Federal Reserve Bank of St. Louis Economic Research database (FRED), we calculate that the average ratio of real gross private domestic investment to real GDP for 1947–2011 is 12.8 percent. Plugging these estimates into equation (10.10) yields a value of SPC equal to about 2.2.

When Shadow Pricing is Unnecessary

For many policy evaluations shadow pricing is not necessary because the project does not displace private investment. For example, many regulations primarily affect private consumption (e.g., through higher prices), not investment. More generally, most new projects are tax-financed, which reduces consumption, not investment, making shadow pricing largely unnecessary.

Criticisms of the SPC and the Resultant SDR estimate

Although this method is theoretically correct:
1) It is difficult to explain to policymakers how and why NPV calculations are made.
2) The method has heavy information requirements concerning the allocation of costs and benefits to investment and consumption. It is somewhat subjective and open to manipulation.
3) Government funds do, in fact, displace investment.

DISCOUNTING INTERGENERATIONAL PROJECTS

So far we’ve discussed only constant (time-invariant) SDRs. There are at least four reasons, however, to suggest the use of a time-declining SDR instead:
1) Empirical evidence suggests that people use lower discount rates for events that occur farther into the future.
2) Long-term environmental and health consequences have very small present values when discounted using a constant rate, often implying that spending a relatively small amount today to avert a costly disaster several centuries in the future is not cost-beneficial.
3) Constant rates do not appropriately take into account the preferences of future, as yet unborn, generations.
4) Constant rates do not appropriately allow for uncertainty as to market discount rates in the future. The text demonstrates that allowing for this uncertainty implies that lower and lower discount rates should be used to discount consumption flows that occur farther and farther in the future.

Numerical Values for Time-Declining Discount Rates
Based on research by Newell and Pizer, the text suggests the following time-declining rate schedule: 3.5 percent from year 0 to year 50, 2.5 percent from year 50 to year 100, 1.5 percent from year 100 to year 200, 0.5 percent from year 200 to year 300, and 0 percent thereafter.

THE SOCIAL DISCOUNT RATE IN PRACTICE

Current discounting practices in governments vary considerably. Table 10.3 presents the prescribed (real) SDR in several countries and the social discount rate method upon which the rate is based.