

**The Appropriate Discount Rate
For Social Policy Analysis:
Discussion and Estimation**

By

**Bruce Peacock
U.S. Department of the Interior
Office of Policy Analysis
1849 C Street, N.W. (Mail Stop 4426)
Washington, D.C. 20240**

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This paper presents a discussion and estimation of the appropriate discount rate for social policy analysis. The discussion is conducted in two parts. Efficiency or opportunity cost considerations are examined first followed by a discussion of intertemporal equity issues. These considerations are then used to guide an estimation of the appropriate discount rate.

Opportunity Cost Considerations

Much of the discussion on the discount rate focuses on the opportunity cost of government spending with respect to forgone private investment and consumption. The following analysis is provided by Lind (1990) who emphasizes the opportunity cost implications of increased capital mobility in a world economy. In the context of a closed economy, a key issue is the crowding out of private investment. The equality of domestic saving (private saving plus government surplus) with private investment in this situation forces a corresponding decrease in private investment given an increase in government spending. However, if capital is sufficiently mobile, private investment will not be crowded out. Rather, foreign capital will be attracted by any profitable private investment for which domestic saving is unavailable. Lind concludes that "the crowding out that has been the focus of most of the closed economy models does not appear to be very important to the analysis of the social discount rate."

Another key issue analyzed by Lind is the method of government finance. When government spending is financed by an income tax, individuals reduce their private saving and consumption according to the marginal propensity to save. This suggests that the discount rate should be a weighted average of the after-tax rate of return on private investment and the consumer's rate of time preference. Given a very small marginal propensity to save, however, the income tax closely approximates a consumption tax and the discount rate closely approximates the consumer's rate of time preference. This result holds regardless of the mobility of capital.

Next consider deficit government financing. In an open economy, both private investment and government spending can be financed in the world credit market. At the margin, then, the after-tax rate of return on private investment equals the world interest rate plus an appropriate risk premium. Similarly, the government can also borrow at a rate equal to the world interest rate plus an appropriate risk premium. Investors are indifferent between the two investments in equilibrium since the different risks are fully accounted for by the different risk premiums. Hence, the certainty rate of time preference for individual investors equals the world interest rate. Individual borrowers, on the other hand, face a consumer loan rate equal to the world interest rate plus an appropriate risk premium, which defines their certainty rate of time preference.

Lind discusses two alternatives available to the government given deficit financing. The government can either invest the borrowed funds in a project or it can reduce taxes by the same

amount. Given the tax reduction, individuals could invest the additional disposable income and receive a certain return equal to the world interest rate or pay off debt and receive a certain return equal to the consumer loan rate. Therefore, individual investors prefer the project if its rate of return, adjusted for risk, exceeds the world interest rate while individual borrowers prefer the project if the consumer loan rate is exceeded. In either case, the appropriate discount rate for evaluating the government project is the individual's certainty rate of time preference.

Lind's basic conclusion, then, is that the consumer's rate of time preference is the appropriate discount rate with which to evaluate government projects given sufficient capital mobility and either tax or deficit financing. This conclusion naturally begs the question of what can be inferred about the consumer's rate of time preference from observable market rates of interest. To approach this question, Lind borrows from recent research in behavioral economics. Consider the seemingly irrational behavior of individuals who simultaneously incur debt on credit cards at high interest rates and invest in retirement plans at considerably lower interest rates. The research suggests that these individuals divide their resources into separate budgets in order to exercise self-control, much like those who take only a certain amount of money to the racetrack in order to protect the mortgage payment. Given this behavior, individuals do not necessarily equate their marginal rates of substitution between present and future consumption with their marginal rates of transformation between present and future income. The disturbing implication is that observable market rates of interest may not reflect the consumer's rate of time preference.

In response to this development, Lind points out that the philosophical basis of benefit-cost analysis is the Kaldor-Hicks compensation criterion. Suppose the government borrows funds to invest in a project. Then, if the present value of net benefits discounted at the government loan rate is positive, the beneficiaries could pay all project costs plus interest and the criterion would be satisfied. This approach suggests that the government loan rate is the appropriate discount rate when choosing among alternative projects that contribute to the government deficit. However, the government loan rate is not necessarily appropriate when also considering the alternative of using the borrowed funds to reduce taxes or when evaluating projects financed by tax increases. Noting that taxes are adjusted infrequently, Lind maintains that decisions affecting the level of taxes are generally not made with respect to particular projects; hence, government spending decisions at the margin reflect changes in the deficit. With this, Lind concludes that the government loan rate should be used as the discount rate when evaluating most government projects.

Intertemporal Equity Considerations

The role of public policy with respect to intertemporal equity is illuminated by the first theorem of welfare economics. *Given an initial endowment, the (perfected) market achieves a Pareto efficient allocation* (Russell and Wilkinson 1979). The initial endowment represents the

distribution of market power among individuals to favorably influence the resulting allocation. Hence, different initial endowments imply different efficient allocations. The efficiency criterion cannot discriminate between efficient allocations because the initial endowment is logically prior to the market allocation. Therefore, society has a legitimate interest in the initial endowment. This interest is presumably based on some concept of social equity.

In the more general intertemporal setting, market power is distributed along two dimensions: individuals and time. The distribution through time is facilitated by a discount rate that assigns relative weights to values occurring in different time periods. Hence, the initial endowment incorporates the discount rate and, by extension of the first theorem of welfare economics, the social interest in the initial endowment is inclusive of the discount rate. Page (1977) provides an excellent discussion of two public policy criteria with respect to intertemporal equity: present value maximization and conservation. This section summarizes his discussion.

Positive observations indicate that markets automatically employ the present value criterion. Producers prefer earlier profits to later profits since earlier profits can be productively invested for even more profits later on. Consumers demonstrate their preferences for earlier utility by their borrowing and lending behavior. The rate at which individual producers discount future profits varies according to the different prices, tax rates, and technologies they face. Similarly, individual consumers possess different rates of time preference. Normative considerations, however, suggest that only one particular discount rate may be appropriate for public policy analysis.

First consider an exchange economy. Assume that utility is positively related to consumption, subject to satiation (i.e. declining marginal utility of consumption). Then, if consumption is dynamically allocated to maximize the un-discounted sum of utility (Ramsey criterion), a perfectly egalitarian distribution through time will result. The declining marginal utility of consumption requires any other allocation to yield a smaller un-discounted sum of utility. This situation is equivalent to discounting utility at the rate of productivity which is zero. If utility is discounted at some positive rate then consumption will decrease through time. Hence, the egalitarian concept of equity is inconsistent with the present value criterion if the discount rate does not equal the rate of productivity.

The same result obtains in the more general context of a productive economy. Now, if consumption is dynamically allocated to maximize the un-discounted sum of utility, consumption will initially increase through time and eventually level off. A unit of consumption sacrificed for productive investment early on will provide increased consumption later on. This sacrifice is constrained by future satiation, forcing the eventual leveling off of consumption. Discounting utility at a positive rate, on the other hand, will make the distribution of consumption through time more egalitarian. Indeed, the distribution becomes perfectly egalitarian if the discount rate equals the rate of productivity.

To demonstrate this result, Page utilizes the following model of a productive economy.

$C_t = \text{Consumption in time period } t$

$U(C_t) = \text{Utility in time period } t; \frac{\partial U}{\partial C_t} > 0, \frac{\partial^2 U}{\partial C_t^2} < 0$

Let: $I_t = \text{Investment in time period } t; I_0 > 0$

$r = \text{Rate of productivity}$

$i = \text{Periodic discount rate}$

Current production is a function of past investment and is either consumed in the current time period or invested for future production.

Let: $C_t + I_t = (1 + r)I_{t-1}$

The present value criterion chooses consumption and investment levels in each time period to maximize the sum of discounted utility subject to the production function.

Maximize: $\sum_{t=0}^T \frac{U(C_t)}{(1+i)^t}$

Subject to: $C_t + I_t = (1 + r)I_{t-1}$

Let: $Z = \sum_{t=0}^T \frac{U(C_t)}{(1+i)^t} - \sum_{t=0}^T L_t [C_t + I_t - (1+r)I_{t-1}]$

Where: $L_t = \text{Lagrangian multiplier in time period } t$

Optimality requires the following conditions.

$$\frac{\partial Z}{\partial C_t} = \frac{\partial U / \partial C_t}{(1+i)^t} - L_t = 0, \forall t \quad [1]$$

$$\frac{\partial Z}{\partial I_t} = -L_t + (1+r)L_{t+1} = 0, \forall t \quad [2]$$

$$\frac{\partial Z}{\partial L_t} = -C_t - I_t + (1+r)I_{t-1} = 0, \forall t$$

Conditions [1] and [2] imply the following condition.

$$\frac{\partial U / \partial C_t}{\partial U / \partial C_{t+1}} = \frac{1+r}{1+i} \quad [3]$$

Condition [3] requires a constant level of consumption through time if the discount rate equals the rate of productivity. Further, noting the declining marginal utility of consumption, the level of consumption decreases (increases) through time if the discount rate is greater (less) than the rate of productivity. Therefore, the present value criterion, when discounting at the rate of productivity, is consistent with an egalitarian concept of equity.

Conservation, the other criterion discussed by Page, is characterized by the following precepts attributed to Barnett and Morse.

- * The regenerative capacity of renewable resources should be protected.
- * Renewable resources should be substituted for nonrenewable resources.
- * Plentiful nonrenewable resources should be substituted for scarce nonrenewable resources.
- * Nonrenewable resources should be recycled.

Sustainable yield is the usual interpretation of the conservation criterion with respect to renewable resources. A commonly stated goal for these resources is maximum sustainable yield. This goal, however, can be inconsistent when applied to more than one renewable resource simultaneously since the sustainable yield of one resource (e.g. spotted white owls) can usually be increased at the expense of the sustainable yield of another resource (e.g. lumber).

Georgescu-Roegen (1979) argues in favor of the conservation criterion, emphasizing that production is ultimately finite in the presence of exhaustible resources. Hence, present value maximization is irrational because future generations will also require resources. He concludes that the counsel to "eat, drink, and be merry today because tomorrow we may die" is appropriate only because humans are mortal. Quasi-immortal entities, such as a nation and its economy, must accommodate future generations.

Page emphasizes the desirable properties of the present value and conservation criteria, noting that it is logically inconsistent to judge one by the standards of another. The present value criterion is automatically administered by markets, achieves a complete allocation of all resources, and is efficient. Further, this criterion is consistent with an egalitarian concept of intertemporal equity when discounting at the rate of productivity. The conservation criterion promotes intertemporal equity by protecting the resource base from generation to generation. Each generation's application of this criterion is to preserve the resource base for the next generation. Hence, this criterion recognizes intertemporal externalities such as groundwater

overdraft. In this sense, the conservation criterion is intertemporally consistent since the plan of resource utilization is not revised by future generations.

Page is able to reconcile the two criteria by recognizing that they have different, but compatible, orientations. The conservation criterion is oriented toward the broad issues of long-term viability while the present value criterion is oriented toward the more narrow issues of efficiency. Once the long-term viability of the economy has been guaranteed by the conservation criterion, efficiency in the administration of the more mundane details of resource allocation by the present value criterion becomes desirable.

This discussion of intertemporal equity began with the first theorem of welfare economics and now it ends with the second theorem. *Any Pareto efficient allocation can be sustained as a market allocation for some initial endowment* (Russell and Wilkinson 1979). Hence, social equity interests can be advanced by the market given the appropriate adjustments to the initial endowment. A common example of such adjustments is the progressive income tax. In the intertemporal setting, adjustments to the initial endowment can occur across time as well as among individuals. Page notes that "by modifying the flows across the boundary between the environment and the economy, myopic markets can be encouraged to be consistent with long-range social goals." In other words, the intertemporal distribution of consumption can be beneficially influenced by selecting and applying an appropriate rate of discount.

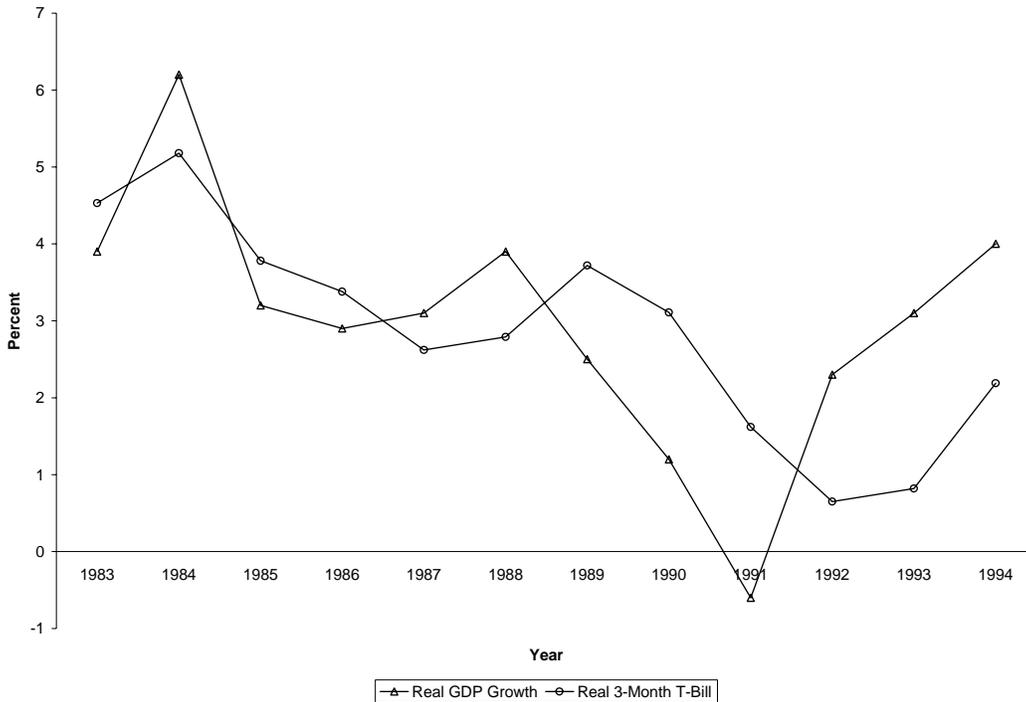
This discussion suggests two approaches to the intertemporal adjustment of the initial endowment. First, conservation goals can be established to address the long run viability of the economy. These goals could be implemented by quantity rationing mechanisms such as a production quota or by price rationing mechanisms such as a royalty or severance tax. Second, the discount rate used in short run social policy analysis can be set equal to the rate of productivity.

Discount Rate Estimation

Two approaches to the appropriate discount rate have been discussed in this paper. The opportunity cost approach addresses the forgone private investment and consumption opportunities resulting from government spending and the intertemporal equity approach addresses legitimate social interests in the intertemporal distribution of consumption and long term viability. These two approaches are used in this section to arrive at an estimate of the appropriate discount rate for social policy analysis.

The intertemporal equity approach recommends discounting at the rate of productivity. The real rates of growth in U.S. Gross Domestic Product (GDP) from 1983 to 1994 (Council of Economic Advisers 1995) are illustrated in Figure 1. This time period corresponds generally with the period characterized by increased capital mobility (Lind 1990) and includes one complete business cycle. The average real rate of growth in GDP over this period is 3.0

Figure 1
Indicators of the Social Discount Rate



percent.¹

The opportunity cost approach relies on the government loan rate to indicate the appropriate discount rate. The 3-month Treasury bill rate is used in this capacity because its short time horizon avoids the consideration of investment risk. Therefore, this instrument reflects individuals' certainty rate of time preference better than securities with longer maturities. Nominal Treasury bill rates for the period 1983 to 1994 (Council of Economic Advisers 1995) were adjusted for inflation by subtracting the rate of change in the GDP implicit price deflator (ibid.). These rates are illustrated in figure 1 and average 2.9 percent.²

Happily, the discount rates indicated by the two approaches are very nearly the same. A

¹ The average real rate of growth in Gross National Product over the same period is also 3.0 percent.

² The average real 3 month Treasury bill rate over the same period when inflation is adjusted for by subtracting the rate of change in the Gross National Product implicit price deflator is 3.0 percent.

3 percent annual discount rate is considered to be representative of both approaches and is recommended as the appropriate discount rate for social policy analysis.

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