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The U.S. Department of Defense (DoD) has proposed outlays of over $242 billion for fiscal 1997. Given historic patterns, this figure will represent a significant portion of overall government spending. For instance, based upon actual FY 95 economic results, the $255 billion DoD outlay represented 3.7% of Gross Domestic Product (GDP), 17.1% of federal outlays, and 11% of net public spending. (Source: *Department of Defense Annual Report to the President and the Congress, March 1996.*) In light of the magnitude of federal expenditures on defense related projects, it is important to consider the appropriate methods for evaluating proposed future projects that commit the U.S. government to expenditures over a number of years. In particular, understanding how to discount future cash flows is critical in project selection.

The Office of Management and Budget (OMB) recently revised Circular Number A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." The circular provides guidance on benefit-cost, cost-effectiveness, and lease-purchase analyses. The guidance applies to all agencies which submit proposals to OMB in support of legislative and budget programs. The major change prescribed by the A-94 was a modification of the social discount rate. Rather than apply a fixed rate of 10%, the revised policy bases the appropriate discount rate to the opportunity cost of either displaced public funds or government borrowing.

This article clarifies procedures for choosing the appropriate discounting and analysis techniques for multi-period DoD projects. Based on our experiences at the Defense Resources Management Institute, the reasons for discounting DoD proposals are not clearly understood - let alone the correct procedures! (When we ask our students what a discount rate is, most of them reply "10%." Rarely do students provide an opportunity cost of capital perspective.) A review of the economics literature, government policies, and the literature pertaining to discounting in defense publications demonstrates no general agreement about the "correct" discount rate to be used in project evaluations. Significant differences in the policies of the General Accounting Office (GAO), the Congressional Budget Office (CBO), and OMB add to the confusion about discounting within the government. Since most DoD analyses fall under the purview of the OMB, our explanations are based upon the OMB implementation policies. This very brief review of discounting begins with an explanation of discounting from the theoretical and empirical economics literature, which guides government policies on social discounting. After discussing OMB discounting policies, we examine specific recommendations and calculations from the OMB Circular A-94 pertaining to DoD proposals. We conclude with a discussion of how to deal with projects of unequal lives, inflation forecasting, and sensitivity analysis.

The Purpose of Discounting

Should we discount government projects? Isn't discounting contrary to the notion of exhausting annual budgetary levels to ensure future year funding? Although contradictory, the answer to BOTH questions is "Yes." Given reduced defense budgets, it is imperative that current and future spending decisions consider alternative uses for government funding. At the highest levels of government, money is taken out of the private sector today to ensure future growth opportunities (such as the funding of the national interstate highway infrastructure). Although less obvious at lower levels of budgetary decision-making, the concept of lost opportunity must drive every major budget decision, especially those which obligate future government expenditures (multi-period activities). Some economists question the need to discount the cash flows of project alternatives once the project is approved by Congress. Clark believes discounting obscures the budgetary implications of examining discounted cash flows. While in theory, this is an unresolved issue, current guidance is clear: Government agencies must discount projects of multi-period cash flows. Therefore, the relevant question becomes, "What is the correct discount rate for government projects?"

The correct discount rate requires understanding the purpose of discounting. Discounting is necessary for two reasons. First, discounting allows comparison of dissimilar multi-period cash flows. Second, it allows comparison of a particular program to the "expected next-best" use of funds; this is the "opportunity cost" concept of resource allocation. Although some disagree, we strongly believe that discounting is NOT designed (or suited) to mitigate the uncertainty of predicting future cash flows. We recommend cash flow sensitivity analysis (based upon distributions of expected cash flows) rather than folding uncertainty into the opportunity cost of fund allocation.

Discount Rates and Opportunity Costs

Within economics literature, the cost of a government project is lost investment and lost consumption potential for the general public (Rosen, 1992). The rate representing lost investment is the *before*-tax rate of

return on investment. For example, if the annual rate of return on the last $1000 of private investment yields 9%, the appropriate social discount rate should be 9%. The opportunity cost of the project is the $90 that would have been generated in the private sector (9% return on a $1,000 investment). Taxes are not relevant; the $90 would either benefit individuals, or individuals and the government; in both cases it is available to society.

Funds for public sector projects generally come at the expense of both investment and consumption. Traditional theories about the social discount rate suggest using a combination of the consumer's and investor's rates. Empirical evidence of completed analyses indicates that the social discount rates are quite varied, in the range of 2-12%![1] However, government restrictions add to the complexity since "the social discount rate is not necessarily equal to the private rate of return. This is because the government cannot (because of restricted debt/monetary policy) transfer resources at will between periods — it cannot in effect trade freely on all markets" (Kolb & Scheraga).

Three arguments suggest that the social discount rate is lower than the opportunity cost revealed by market rates of return. The *first* argument contends that the private sector devotes too few resources for saving — implicitly applying a too-high discount rate to future benefits and returns (Gramlich 1981, p.97). Rosen suggests this omniscience and benevolence is unrealistic — even selfish individuals often find it in their personal interest to engage in long-term projects that will benefit future generations. The *second* argument is paternalistic: people cannot adequately weigh future benefits. Assuming individuals are not farsighted enough to envision future, they discount the value of future benefits at too high a rate (Pigou, 1932, Chapter 2). The *third* argument is that the market under-estimates the positive, synergistic effects of investments. Therefore the market actually under-values the real benefits of investment activity (Arrow 1962). A lower discount rate is one (indirect) method of remedying this error in estimating future benefit.

Conversely, Quirk & Terasawa (1991) suggest the social discount rate is higher than the opportunity cost revealed by market rates of return. This argument is based upon the "opportunity cost rate of return" concept, which utilizes a discount rate equal to the "maximal rate of return available from the portfolio of unfunded government projects" (Quirk & Terasawa, pp. 16-17). The authors contend that people make choices given their personalities and abilities to save, often ignoring potential savings. For example, it is not uncommon for parents to save for their children's college education at a low rate of interest, while simultaneously borrowing on their credit cards at annual rates of 18% or more. Lacking a dominant theory, it is logical to employ a combination of consumption and investment rates to represent the social discount rate. In many cases, this

Figure 1: Summary of Discount Policy by Type of Government Project

Type of Project or Analysis	Explanation and Examples	Discount Policy and Recommendations
Public Investment or Regulatory Program (Cost-Benefit)	Benefits and costs provided to the public. Example: Highway construction	Base case: 7%, use GDP deflator to adjust for inflation. Perform Sensitivity Analysis. Find IRR if appropriate.
Cost-Effectiveness	Benefits are equal or unknown. Example: Weapons systems	Base case: Real Treasury Borrowing Rate on marketable securities, matched to expected system life cycle.
Lease-Purchase	Analysis of purchase versus lease of comparable system. Example: Lease vs Purchase military family housing	
Internal Government Investment (cost-benefit)	Federal investments providing increased federal revenues or decreased federal costs. Example: An investment in a more energy efficient building system	
Asset Sale	Analysis of value of government asset. Example: Sale of property.	

Note: Source is OMB Circular A-94, pp.9-11. Analyses must be performed in either nominal or real dollars (not both). The rates shown assume analysis based upon real dollars. Use 7% if project provides a mix of internal and external benefits.

rate exceeds the 2-12% range employed by traditional economic analyses.

Another concern related to applying market rates as proxies of the cost of government spending involves the source of funds. Does it matter whether or not the project is financed with U.S. government borrowing or a tax increase? A tax increase represents both lost consumption and lost investment possibilities for the private sector (which implies a combination of the rates). The cost of U.S. government borrowing is the rate paid on Treasury bills with maturity comparable to the program being evaluated (which would imply using the same Treasury Bill rate while discounting). Does government borrowing displace other investments, some of which may have higher potential market return rates? These questions highlight the difficulties associated with assuming a social discount rate equal to a market or Treasury rate.

Lind (1990) proposes the social discount rate be viewed in light of changes in the world economy. He suggests that the world economy is a (fairly) open economy, in which governments borrow and lend on the world market at world interest rates. Although his assumption that the U.S. can freely borrow and lend on the world market, without affecting interest rates, is controversial, Lind does prescribe policies relevant to several types of projects.

In sum, selecting the "appropriate" discount rate is much more complex than merely selecting a single value for all project initiatives. Not surprisingly, government agencies have reacted to the variety of opinions by formulating different discounting policies (depending upon their respective sources).

- *General Accounting Office (GAO)* policies are consistent with basic economic principles and fairly easy to implement *(GAO/OCE-17.1.1 Discount Rate Policy)*. The base case GAO discount rate is the interest rate for marketable Treasury debt with maturity comparable to the program being evaluated.
- *Congressional Budget Office (CBO)* policy, on the other hand, applies a base-case discount rate of 2% (Hartman, 1990).
- *Office of Management and Budget (OMB)* has chosen 7% as the base-case measure of the average pre-tax rate of return on an investment in the private sector. However, OMB prescribes discount rates depending upon the recipients of the benefits. For instance, OMB prescribes the base-case 7% only for analyses with measurable benefits and costs accruing to directly to society. OMB prescribes using Treasury Rates of comparable time periods to the project life cycle as discount rates for Internal projects, cost-effectiveness analyses, lease-purchase, and asset sales proposals.

OMB Categorization of Government Projects by Costs and Benefits

As mentioned, the OMB base-case discount rate policy depends upon the type of projects being analyzed. The OMB circular A-94 provides guidance for project evaluation. When costs and benefits are measurable, the circular requires a classification of costs and benefits as either Internal or External. This determination affects the discount rate applied during the analysis.

OMB defines External benefits and costs as those that have direct, measurable impact on the public. For example, suppose a government agency is considering an entirely new service or initiative. If this initiative will displace (or provide) funds from (to) the public, it is an External program. In this instance, the public investment required to provide future benefits displaces private investment and consumption, so the appropriate discount rate must account for the opportunity cost of both consumption and investment. The A-94 dictates a base-case rate of 7% for External cost-benefit analyses, accompanied with extensive discount rate sensitivity analyses.

For other projects, the cash flows affect only Internal government budget allocations. For example, the decision to consolidate depot operations is an example of an internal program. The depot charges government agencies for their services to cover their operating costs. This is an Internal cost-benefit initiative because benefits and costs primarily affect only the government. Of course, even in our example, the private sector ultimately receives benefits (a private company will receive a contract to perform the consolidation). However, the initiative primarily lowers the costs of depot operations which, in turn, reduces their charges to government agencies for maintenance activities.

Other projects within this Internal category include projects with undetermined or undefined benefits. For example, determining dollar benefits of the Advanced Tactical Fighter aircraft is impossible. In such instances, Internal cost-effectiveness analyses are required, and the relevant opportunity cost is the marginal government cost of borrowing. All cost-effectiveness analyses, according to OMB, require a discount rate equal to the U.S. Treasury's borrowing rates (Treasury bills with maturity lengths equal to the project life cycle).

Lease-purchase and government asset sale decisions are also considered to have costs only to the federal government. Again, OMB requires these types of projects to be discounted using Treasury borrowing rates. Figure 1 summarizes the five projects types and the mandated discount policy for each.

A-94 Recommendations for Within DoD

As mentioned, OMB Circular A-94 requires determination of the types of costs and benefits associated with proposed projects. If costs and benefits are External — as in the case of the Bell-Boeing V-22 Osprey, which is considered a joint project with a commercial firm — OMB suggests using 7% in performing the cost-benefit analysis. The majority of DoD activities do not lend themselves to a dollar evaluation of benefits (e.g., weapons systems evaluations). In these cases, benefits are assumed equal, unknown, or immeasurable. OMB's position is based upon the opportunity cost of competing government projects. Thus,

once again, the government's cost of borrowing (Treasury Rate) is the appropriate discount rate.

In summary, the type of analysis supporting DoD decisions depends upon the decision authority. Whenever Congressional approval has been previously granted (and the DoD is merely selecting the best option of meeting requirements), selection of the most cost-effective alternative is an Internal governmental budget allocation decision. In this case, the government cost of borrowing (Treasury rate) is the appropriate discount rate. If Congress has not previously approved a program, it must be evaluated against non-DoD opportunities; thus the 7% discount rate applies. (Recall our original question of whether to discount. The level of analysis does make a difference in the "rate," yet the concept remains: Discount multi-period projects.)

We have mentioned that OMB policy stipulates calculating a base-case analysis for constant dollar costs using comparable, real Treasury Borrowing Rates. Comparability requires that the maturity date of the Treasury bill rate match the life cycle of the project. Each year the circular updates relevant multi-period rates. Figure 2 shows current FY 97 rates from A-94, Appendix C. Rates are provided annually at the time of the President's budget submission to Congress (and are available on the World Wide Web at http://www.whitehouse.gov /WH/EOP/omb or by calling OMB at 202-395-3381). Use linear interpolation to calculate the discount rate for programs with different life cycle durations than shown. For example, a 4-year project (in real dollars) would be evaluated using a discount rate of 2.2%. Use 30-year rates for projects exceeding 30 years.

OMB will accept other justified discount rates. For example, construction projects often result in the government taking on a construction loan. In this case, the prevailing market construction loan rate would be suitable for discounting alternatives. In all cases, discount rate sensitivity analysis should be conducted.

The discount policy for lease-purchase proposals is straightforward. Use the Treasury rates as given in A-94, Appendix C. Note, however, that lease-purchase analysis does not apply to the decision to purchase an asset. Lease-purchase cost-benefit analyses apply only after the decision is made to procure services of an asset (A-94, p. 15).

Discount Factors Should Match Specific Cash Flows

Detailed analyses require calculation of net present values (NPVs) of benefits minus costs for cost-benefit analyses, or the present discounted costs, for cost-effectiveness studies. Although the timing of cash flows varies by project, discount rates are published only as annual values. Therefore, the timing of cash flows affects the calculation of the discount factors. We examine end-of-the-year, mid-year, quarterly, and continuous discount factor calculations. If r is the annual discount rate, and n is the year being discounted (or q is the quarter being discounted), then basic discounting factors according to OMB specification are:

End-of-year: $\dfrac{1}{(1+r)^{n}}$

Mid-year: $\dfrac{1}{(1+r)^{(n-0.5)}}$

End-of-quarter: $\dfrac{1}{(1+r)^{q/4}}$

Mid-quarter: $\dfrac{1}{(1+r)^{(q-0.5)/4}}$

For example, compare the discounted value of a $100 cash flow, at an annual discount rate of 6%, when cash flows occur first at the end-of-the-second-year, then at mid-year of the second year:

End-of-year, second year:

$$\$100 * \frac{1}{(1+0.06)^{2}} = \$89.00$$

Mid-year, second year:

$$\$100 * \frac{1}{(1+0.06)^{(2-0.5)}} = \$91.63$$

Notice that we have used the method suggested by OMB (also found in Air Force Regulation 1 73-1 5) as opposed to the conventional method used in business and finance. The conventional method uses the general formula, where r is the annual interest rate, m is the number of discounting periods per year, and n is the number of discounting periods. According to the conventional method, the present value of $100 due at mid-year of the second year is:

Mid-year, second year:

$$\$100 * \frac{1}{(1+0.06/2)^{3}} = \$91.50$$

Notice the difference between the calculations; the OMB method gives a discounted present value of $91.63, and the conventional method gives $91.50. Mercier notes that the OMB (& Air Force) method ignores the impact of the frequency of payments, while the conventional method clearly recognizes this impact and differentiates between the nominal discount rates and effective discount.[3] Sensitivity analysis will partially mitigate this distinction.

The A-94 provides a table of End-of-the-Year, Mid-Year and Beginning-of-Year discount factors, assuming an annual discount rate of 7%. If the actual timing of cash flows is uncertain, analysts are instructed to assume that cash flows occur in a steady stream throughout the period and apply the mid-period discount factor. We note mid-period factors do not give exact expectations of costs and benefits; rather, the mid-period assumption is a reasonable way to account for ("average") cash flows when the exact timing of those flows is unknown. Analysts must realize the tradeoff between the timing and estimation of cash flows, and select the most appropriate discounting period. As the timing (# of periods per year) in-

Figure 2: Real and Nominal Discount Rates for Projects of Varying Length

Cash Flows:	3-Year	5-Year	7-Year	10-Year	30-Year
Real	2.1%	2.3%	2.5%	2.7%	2.8%
Nominal	5.0%	5.3%	5.5%	5.7%	5.8%

Note: The U.S. Treasury's borrowing rates change daily. The rates suggested by the update to Appendix C in the A-94 (valid only through February, 1997) for 3- to 10-year (nominal) projects ranged from 5.4 to 5.7%.

creases, estimation of exact cash flows becomes more costly and less accurate. (Annual time periods are nearly always sufficiently precise.) As a cautionary note, Appendix B of Circular A-94 states that mid-year factors are calculated "by multiplying year-end factors by 1.0344 (the square root of 1.07). This illustration is misleading. It applies ONLY for a 7% discount rate. We strongly recommend using the correct formulas instead of tables. Doing so ensures proper calculation of discount factors as well as facilitating subsequent discount rate sensitivity analyses.

Further Considerations

We will now discuss a few other important issues: evaluation of unequal-life projects, inflation, and sensitivity analysis. Comparison of the net costs of unequal-life projects requires consideration of the time discrepancy across alternatives. An alternative with a projected life-cycle of five years cannot be compared directly to an alternative which has a life-cycle of ten years because arguing equal effectiveness between the two alternatives is not sensible. To compensate for unequal life cycles, the best approach involves calculating a salvage value of the longer alternative in the last year of the shorter alternative, then comparing the two equal-duration alternatives. Clearly, obtaining an accurate out-year salvage value estimation is a challenge. Rather than attempt to obtain "the" estimate, determine three estimates: the best, worst, and likely cases. Then, perform the subsequent present value calculations using all three salvage values.

Throughout this article, we have assumed real dollar estimates of cash flows. This assumes either cash flow estimates were in today's dollars, or then-year (nominal) estimates have been adjusted for inflation. Hopefully, the former is applicable, since accounting for inflation is difficult. The A-94 assumes that inflation changes according to the rate of increase in the GDP. Analysts are safe using the GDP economic deflator to create real dollar estimates from nominal values. If more accurate (?) estimates are necessary, forecasts from independent forecasting agencies such as Wharton Econometric Forecasting Associates are available.

Rather than attempting to predict inflation, it will likely prove more expedient to rely upon the GDP growth estimates accompanied with extensive sensitivity analysis of inflation rates. Do NOT combine inflation and discount rates into one discount factor. While mathematically the results may be identical, all intuition related to the opportunity costs of foregone choices will be lost. Perform separate sensitivity analyses. Account for inflationary effects first, then opportunity costs (discount rates). Reasonable assumptions and methodical testing of alternatives will provide robust outcomes and create confidence in project recommendations.

Conclusion

This article reviews the literature on social discounting, the OMB Circular No. A-94 related to government procedures for discounting, and important aspects of discount policy for DoD projects. OMB's policy requires discount rates to be chosen based on the types of costs and benefits associated with the proposal. The majority of DoD projects should use rates other than the 7% highlighted in the main text of the Circular. Project duration, timing of cash flows, and uncertainty are a few important considerations an analyst must address in correctly performing a cost-benefit, cost-effectiveness, or lease-purchase analysis. Closer attention to the economy (using Treasury Bill rates as discount rates) produces cost-benefit (effectiveness) analyses which are more relevant for decision makers. Analysts working on defense projects must know when and how to apply correct discounting techniques in order to insure that their analyses accurately reflect the opportunity costs of decisions at hand. The list of references accompanying this article contains several excellent conceptual and applied sources regarding discount rates and present value analysis.

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Endnotes

1. *This issue addresses social discounting exclusively. Literature (by Lind, Scheraga, Quirk and Terasawa, and others) generally suggests that a real rate of return of about 2% accurately approximates the opportunity cost of funds displaced from the private sector by the government.*
2. *However, Mercier makes several errors in his calculations (for example, his conventional factors in Table 2 are not correct) that are confusing to practitioners.*

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